

North Dakota Storm List Appendix F

This appendix contains all the storm data used to adjust each storm in-place. Information is provided representing the SPAS analyzed data, the information used to locate the storm representative dew point/SST location, and other pertinent information regarding the In-place storm representative dew point and rainfall. The adjustments applied to each storm to each grid point to calculate the TAF over the entire domain are contained in the PMP Tool database.

In this appendix, daily synoptic weather maps are provided for a period starting a few days before the storm and continuing to a few days after the storm. Daily weather maps covering the period from 1871 through 2002 are from the U.S. Daily Weather Maps Archive, [NOAA Climate Database Modernization Program \(CDMP\)](#), National Climatic Data Center, Asheville, NC, and the NOAA Central Library Data Imaging Project. Daily synoptic weather maps from 2002 through 2021 are from the NOAA Weather Prediction Center Daily Weather Maps web page, <http://www.hpc.ncep.noaa.gov/dailywxmap/index.html>.

For all storms which had a USACE Storm Studies analysis previously completed, those pertinent data sheet pages are included. These data came from the USACE Storm Rainfall in the United States, Depth-Area-Duration Data files (USACE, 1973). In addition, there are several storms which include a hand drawn transposition limit map complete by the NWS. These maps were recovered from the Hydrometeorological Design Studies Center office in Silver Spring, MD and are archived on AWA's server. Descriptions of transposition limits of key storms are contained in several HMRs (e.g., HMR 52 Figure 26 and HMR 53 Table 2 (Ho and Reidel, 1980)).

Table F.1 Short storm list used for PMP Development-general storms. Maximum Total Rainfall is the location with the largest rainfall accumulation for the total storm duration.

SPAS_ID	Storm Name	State	Lat	Lon	Year	Month	Day	Max Rainfall	Elevation	PMP_TYPE
SPAS_1335_1	WARRICK	MT	48.0791	-109.7041	1906	6	5	13.69	4123	General
SPAS_1697_1	IRONWOOD	MI	46.4542	-90.2064	1909	7	21	13.41	1443	General
SPAS_1336_1	SPRINGBROOK	MT	47.3642	-105.7778	1921	6	17	15.20	2687	General
SPAS_1325_1	SAVAGETON	WY	43.8458	-105.8042	1923	9	27	17.56	5056	General
SPAS_1433_1	COLLINSVILLE	IL	38.6708	-90.0042	1946	8	12	19.07	563	General
SPAS_1583_1	COUNCIL GROVE	KS	38.6458	-96.6208	1951	7	9	18.56	1430	General
SPAS_1630_1	BOLTON	ONT	43.8375	-79.9792	1954	10	14	11.23	1250	General
SPAS_1527_1	IDA GROVE	IA	42.3625	-95.4958	1962	8	30	12.67	1329	General
SPAS_1504_1	PELICAN MOUNTAIN	AB	55.5542	-113.6625	1970	6	26	11.25	2733	General
SPAS_1738_1	HARLAN	IA	41.7208	-95.2125	1972	9	10	15.81	1368	General
SPAS_1502_1	VETERAN	AB	51.8625	-110.4292	1973	6	13	9.56	2185	General
SPAS_1337_1	PARKMAN	SK	49.7020	-101.8958	1985	8	3	15.75	2080	General
SPAS_1206_1	BIG RAPIDS	MI	43.6125	-85.3125	1986	9	9	13.18	987	General
SPAS_1735_1	COLDWATER	MI	41.9625	-85.0042	1989	5	30	9.2	960	General
SPAS_1297_1	WARROAD	MN	48.8750	-95.0850	2002	6	9	14.62	1099	General
SPAS_1048_1	HOKAH	MN	43.8125	-91.3625	2007	8	18	18.26	1092	General

Table F.2 Short storm list used for PMP Development-hybrid storms. Maximum Total Rainfall is the location with the largest rainfall accumulation for the total storm duration.

SPAS_ID	Storm Name	State	Lat	Lon	Year	Month	Day	Max Rainfall	Elevation	PMP_TYPE
SPAS_1699_1	HAYWARD	WI	45.9958	-91.0958	1941	8	28	15.35	1377	Hybrid (G/L)
SPAS_1183_1	EDGERTON	MO	40.4125	-95.5125	1965	7	18	20.76	915	Hybrid (G/L)
SPAS_1725_1	LEONARD	ND	46.5958	-97.3375	1975	6	29	20.66	1061	Hybrid (G/L)
SPAS_1286_1	AURORA COLLEGE	IL	41.4575	-88.0699	1996	7	16	18.13	636	Hybrid (G/L)
SPAS_1228_1	FALL RIVER	KS	37.6300	-96.0500	2007	6	30	25.50	889	Hybrid (G/L)
SPAS_1296_1	DULUTH	MN	47.0150	-91.6650	2012	6	19	10.73	611	Hybrid (G/L)

Table F.3 Short storm list used for PMP Development-local storms. Maximum Total Rainfall is the location with the largest rainfall accumulation for the total storm duration.

SPAS_ID	Storm Name	State	Lat	Lon	Year	Month	Day	Max Rainfall	Elevation	PMP_TYPE
SPAS_1426_1	COOPER	MI	42.3764	-85.6103	1914	8	31	13.39	875	Local
SPAS_1521_2	BASSANO	AB	50.7792	-112.5708	1923	5	29	7.72	2690	Local
SPAS_1427_1	BOYDEN	IA	43.1958	-95.9958	1926	9	17	24.22	1438	Local
SPAS_1736_1	STANTON	NE	41.8208	-97.0292	1944	6	10	17.49	1571	Local
SPAS_1434_1	HOLT	MO	39.4542	-94.3292	1947	6	18	17.62	949	Local
SPAS_1734_1	THIEF RIVER FALLS	MN	48.1625	-96.2625	1949	5	27	9.96	1146	Local
SPAS_1334_1	BUFFALO GAP	SK	49.1146	-105.2896	1961	5	30	10.50	2,600	Local
SPAS_1030_1	DAVID CITY	NE	41.2132	-97.0710	1963	6	24	15.98	1627	Local
SPAS_1324_1	GLEN ULLIN	ND	47.3041	-101.3875	1966	6	24	12.87	1724	Local
SPAS_1209_1	WOOSTER	OH	40.9146	-81.9729	1969	7	4	14.95	1164	Local
SPAS_1744_1	EAST TROUT LAKE	SK	54.4375	-104.7542	1974	7	10	12.32	1650	Local
SPAS_1035_1	FOREST CITY	MN	45.2394	-94.5404	1983	6	20	17.00	1082	Local
SPAS_1210_1	MINNEAPOLIS	MN	44.8895	-93.4021	1987	7	23	11.55	940	Local
SPAS_1673_1	HARROW	ONT	42.0042	-82.9375	1989	7	19	17.74	600	Local
SPAS_1036_1	PAWNEE CREEK	CO	40.7752	-103.6253	1997	7	29	13.58	4497	Local
SPAS_1177_1	VANGUARD	SK	49.9218	-107.2100	2000	7	3	15.29	2487	Local
SPAS_1726_1	TURTLE RIVER	ND	47.9550	-97.7550	2000	6	13	20.00	1224	Local
SPAS_1033_1	OGALLALA	NE	41.1247	-101.7166	2002	7	6	14.92	3213	Local
SPAS_1220_1	DUBUQUE	IA	42.4400	-90.7500	2011	7	27	15.14	902	Local
SPAS_1727_1	DRUMMOND	WI	46.3150	-91.4150	2018	6	14	17.33	1303	Local
SPAS_1728_1	CROSS PLAINS	WI	43.1450	-89.6150	2018	8	21	16.24	1006	Local
SPAS_1729_1	FOUNTAIN	MI	44.0350	-86.1850	2019	7	20	15.77	697	Local

Table of Contents

GENERAL STORMS	6
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1335_1 SPAS ANALYSIS.	7
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1697_1 SPAS ANALYSIS	17
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1336_1 SPAS ANALYSIS	26
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1325_1 SPAS ANALYSIS	37
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1433_1 SPAS ANALYSIS	46
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1583_1 SPAS ANALYSIS	56
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1527_1 SPAS ANALYSIS	64
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1630_1 SPAS ANALYSIS	70
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1504_1 SPAS ANALYSIS	76
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1738_1 SPAS ANALYSIS	82
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1502_1 SPAS ANALYSIS	88
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1337_1 SPAS ANALYSIS	94
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1206_1 SPAS ANALYSIS	100
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1735_1 SPAS ANALYSIS	106
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1297_1 SPAS-NEXRAD ANALYSIS.....	112
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1048_1 SPAS-NEXRAD ANALYSIS.....	119
HYBRID STORMS	125
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1699_1 SPAS ANALYSIS	126
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1183_1 SPAS ANALYSIS	136
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1725_1 SPAS ANALYSIS	142
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1286_1 SPAS ANALYSIS	149

STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1228_1 SPAS-NEXRAD ANALYSIS.....	155
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1296_1 SPAS-NEXRAD ANALYSIS.....	161
LOCAL STORMS	167
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1426_1 SPAS ANALYSIS	168
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1521_2 SPAS ANALYSIS	177
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1427_1 SPAS ANALYSIS	186
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1736_1 SPAS ANALYSIS	196
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1434_1 SPAS ANALYSIS	208
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1734_1 SPAS ANALYSIS	219
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1334_1 SPAS ANALYSIS	231
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1030_1 SPAS ANALYSIS	237
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1324_1 SPAS ANALYSIS	244
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1209_1 SPAS ANALYSIS	250
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1744_1 SPAS ANALYSIS	256
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1035_1 SPAS ANALYSIS	263
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1210_1 SPAS ANALYSIS	269
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1673_1 SPAS ANALYSIS	275
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1036_1 SPAS ANALYSIS	282
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1177_1 SPAS-NEXRAD ANALYSIS.....	288
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1726_1 SPAS-NEXRAD ANALYSIS.....	294
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1033_1 SPAS-NEXRAD ANALYSIS.....	300
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1220_1 SPAS-NEXRAD ANALYSIS.....	306

STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1727_1 SPAS-NEXRAD ANALYSIS.....	312
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1728_1 SPAS-NEXRAD ANALYSIS.....	318
STORM PRECIPITATION ANALYSIS SYSTEM (SPAS) FOR STORM #1729_1 SPAS-NEXRAD ANALYSIS.....	324

General Storms

Storm Precipitation Analysis System (SPAS) For Storm #1335_1

SPAS Analysis

General Storm Location: Ohio (45.0,-84.0,37.0,-77.5)

General Storm Location: Warrick, MT

Storm Dates: June 5-9, 1906

Event: Mid-latitude cyclone with embedded convection

DAD Zone 1

Latitude: 48.0791°

Longitude: -109.7041°

Max. grid rainfall amount: 348mm

Max. observed rainfall amount: 338mm (Warrick, MT)

Number of Stations: 50

SPAS Version: 9.5

Base Map Used: Digitized HMR Isohyetal Map (plus some manual edits)

Spatial resolution: 30 seconds (degree: minute: second, WGS84, ~ 0.3 mi², 0.78 km²)

Radar Included: No

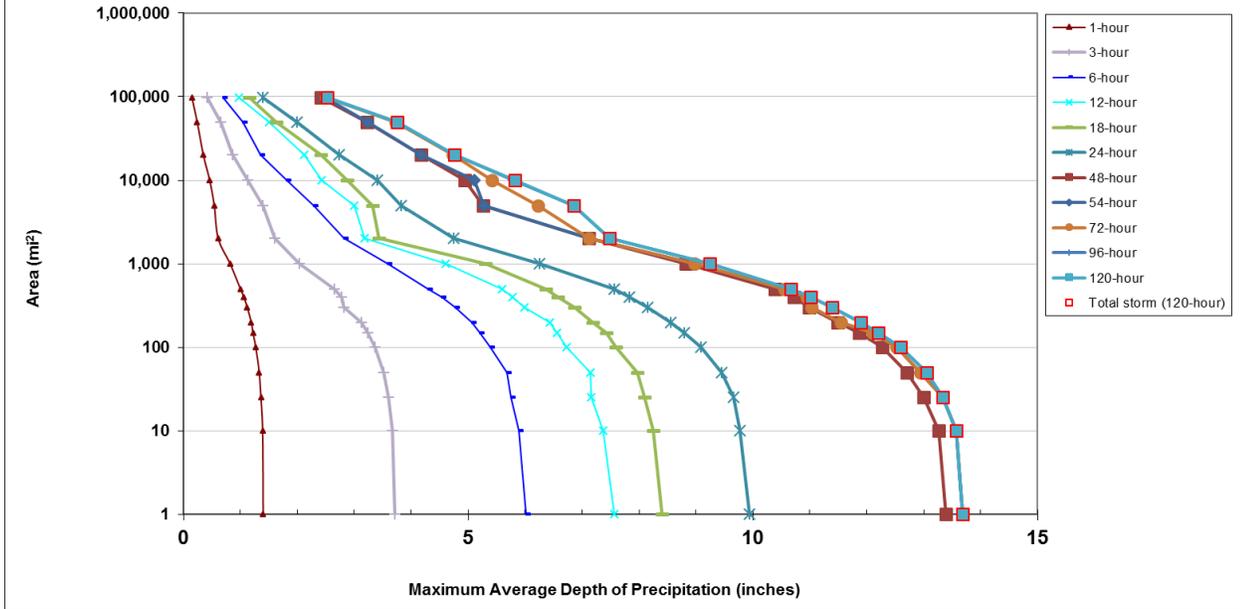
Depth-Area-Duration (DAD) analysis: Yes

Reliability of Results: Very strong winds accompanied this storm, especially the morning of June 6th through the morning of June 8th, likely resulted in severe gauge under-catch. Only 5 hourly gauges (some estimated) were utilized, therefore casting higher than usual uncertainty on the timing of precipitation during this large storm. The timing is most reliable at 6-hour intervals; use caution with the 1-5 hour DAD results. Very few daily/supplemental stations were available for this storm, so the precipitation magnitudes are somewhat uncertain as well. The results are consistent with USACE/NWS analysis (MR 5-13) of this storm. This storm was analyzed as part of HMR55A. The influence of orographically significant terrain near Warrick (and the wind-induced under-catch) justified a slight increase in the measured storm maximum from 13.31" to 13.69".

SPAS 1335 - June 5 (0700 UTC) - June 10 (0600 UTC), 1906
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

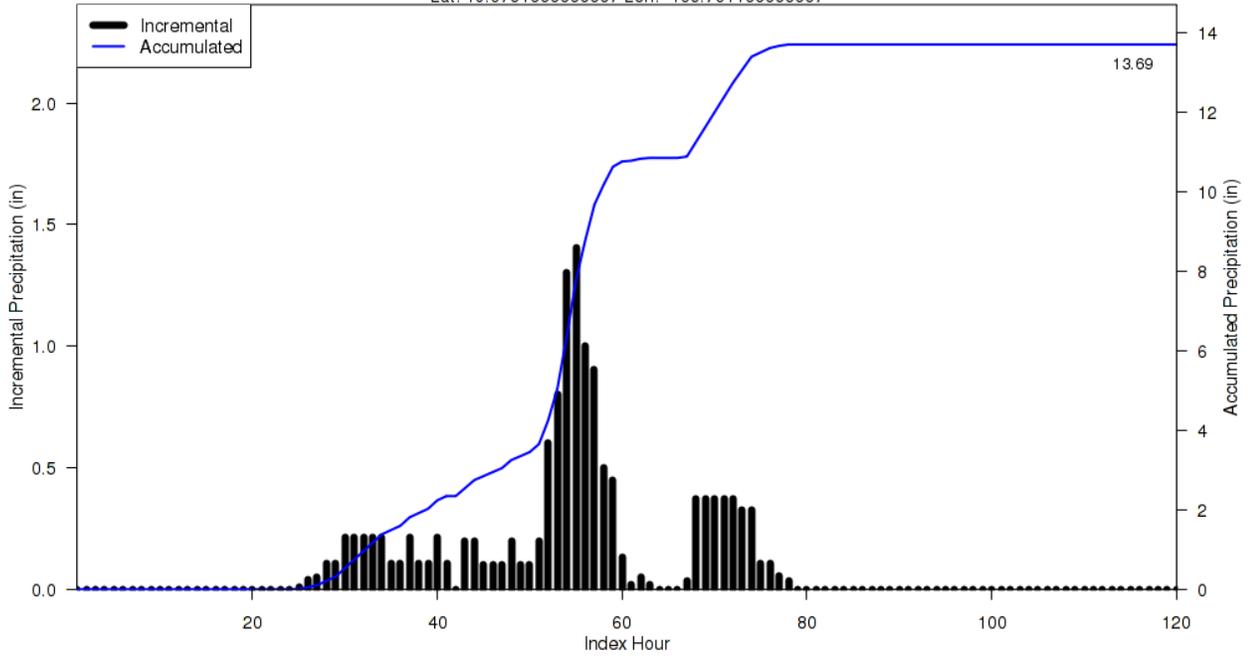
Area (mi ²)	Duration (hours)											
	1	3	6	12	18	24	48	54	72	96	120	Total
0.2	1.40	3.71	6.02	7.57	8.41	9.94	13.39	13.69	13.69	13.69	13.69	13.69
1	1.40	3.71	6.02	7.57	8.41	9.94	13.39	13.69	13.69	13.69	13.69	13.69
10	1.39	3.67	5.89	7.37	8.25	9.78	13.26	13.57	13.57	13.57	13.57	13.57
25	1.36	3.60	5.75	7.16	8.10	9.66	13.00	13.33	13.33	13.34	13.34	13.34
50	1.33	3.51	5.68	7.15	7.97	9.45	12.70	12.94	12.95	13.06	13.06	13.06
100	1.27	3.36	5.39	6.73	7.59	9.09	12.28	12.53	12.53	12.59	12.59	12.59
150	1.22	3.24	5.20	6.56	7.43	8.80	11.87	12.10	12.10	12.21	12.21	12.21
200	1.19	3.13	5.07	6.43	7.19	8.56	11.49	11.55	11.55	11.89	11.89	11.89
300	1.12	2.82	4.77	5.99	6.87	8.16	10.99	11.03	11.03	11.40	11.40	11.40
400	1.06	2.78	4.53	5.78	6.58	7.83	10.72	10.95	10.95	11.01	11.01	11.01
500	1.00	2.65	4.30	5.60	6.37	7.57	10.39	10.55	10.55	10.67	10.67	10.67
1,000	0.82	2.04	3.58	4.60	5.31	6.25	8.82	8.98	8.98	9.24	9.24	9.24
2,000	0.61	1.60	2.82	3.18	3.43	4.75	7.12	7.12	7.12	7.48	7.48	7.48
5,000	0.54	1.40	2.29	3.00	3.32	3.82	5.26	5.28	6.23	6.85	6.86	6.86
10,000	0.46	1.13	1.81	2.43	2.87	3.41	4.94	5.11	5.41	5.80	5.82	5.82
20,000	0.35	0.86	1.35	2.12	2.41	2.74	4.17	4.17	4.73	4.76	4.76	4.76
50,000	0.24	0.65	1.05	1.50	1.63	2.00	3.23	3.24	3.73	3.75	3.75	3.75
96,655	0.15	0.41	0.69	0.98	1.15	1.40	2.41	2.49	2.51	2.52	2.52	2.52

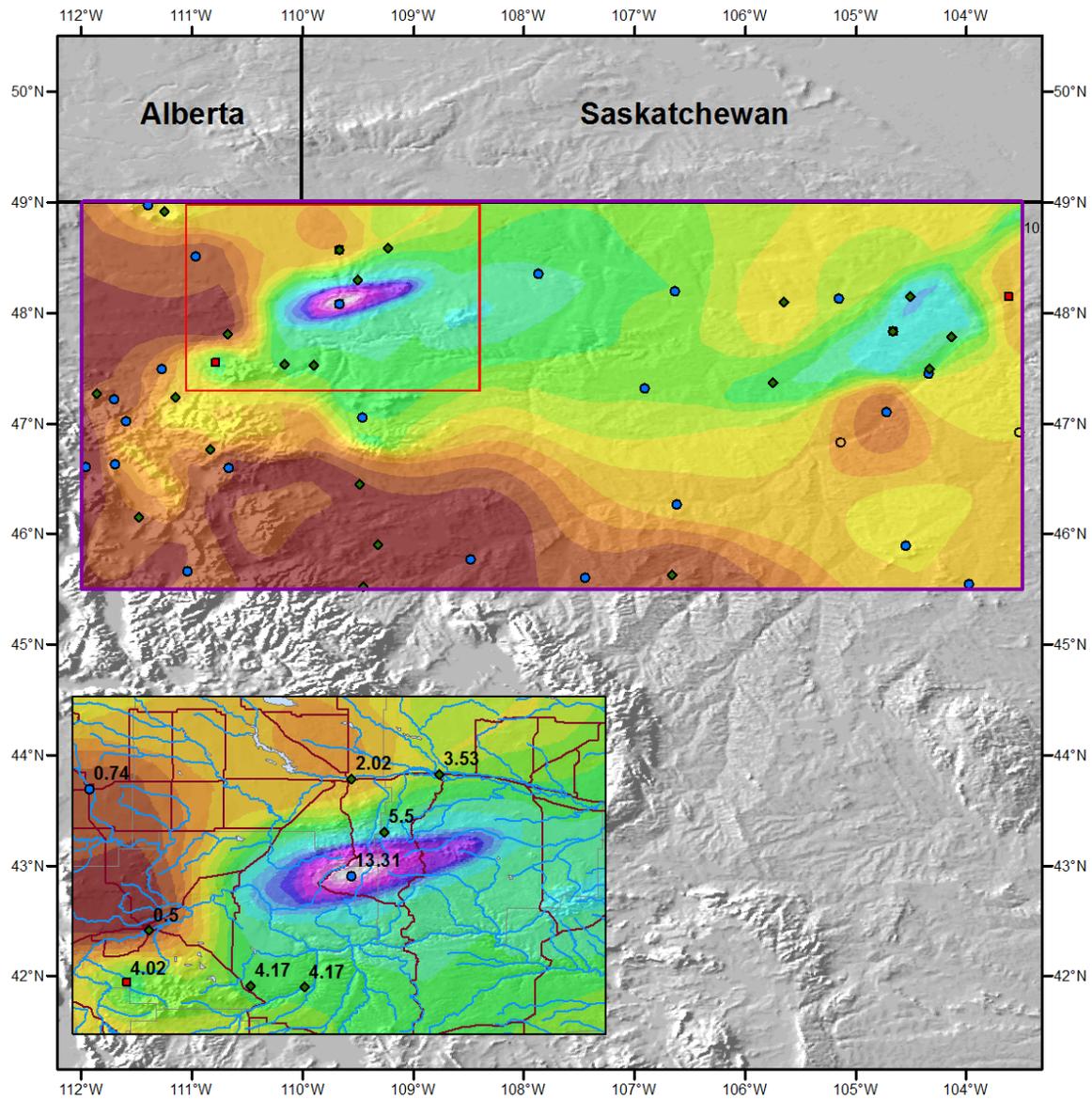
SPAS #1335 DAD Curves Zone 1
June 5-10, 1906



SPAS 1335 Storm Center Mass Curve Zone 1
June 5 (0700UTC) to June 10 (0600UTC), 1906

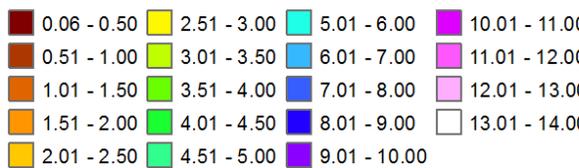
Lat: 48.0791666666667 Lon: -109.704166666667



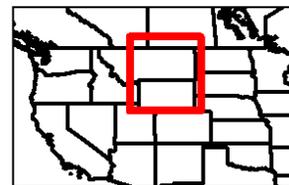
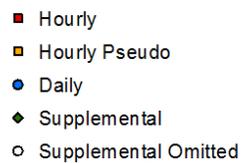


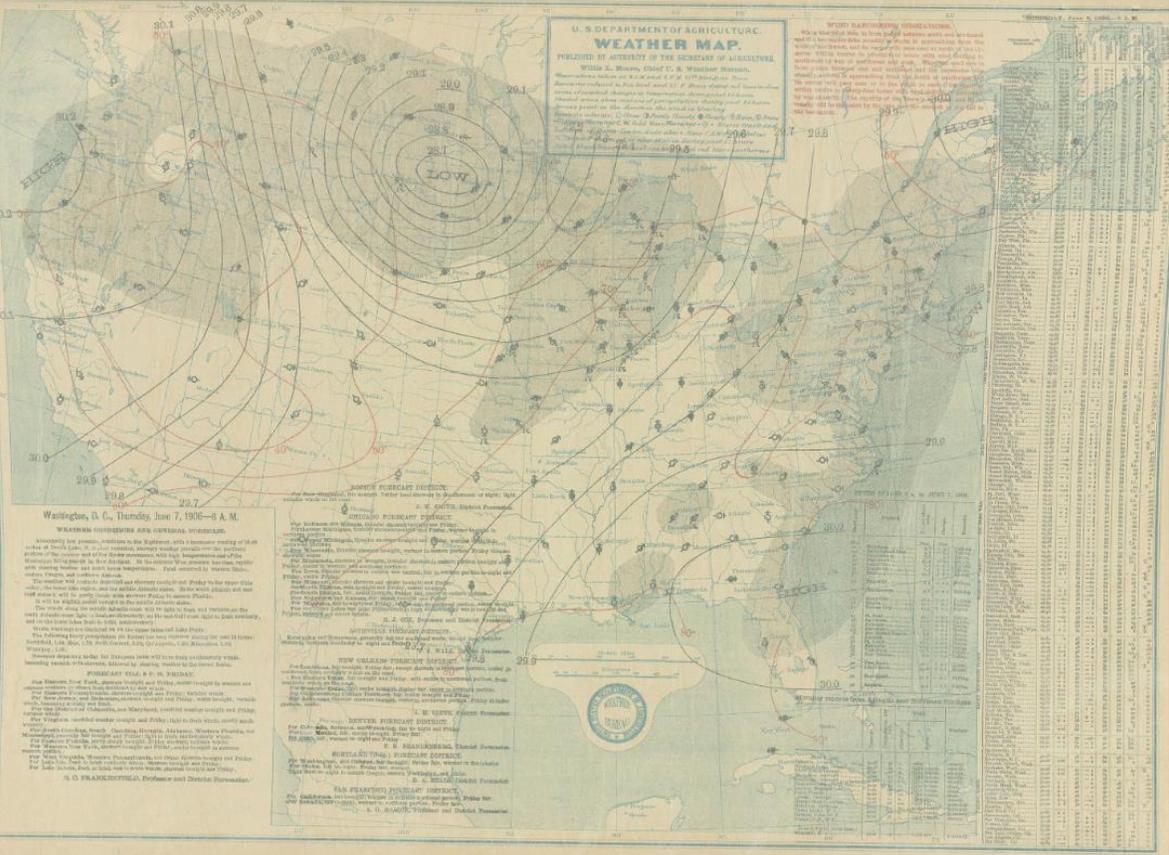
Total 120-hour Precipitation (inches)
June 5, 1906 0700Z - June 10, 1906 0600Z
SPAS #1335

Precipitation (inches)



Stations





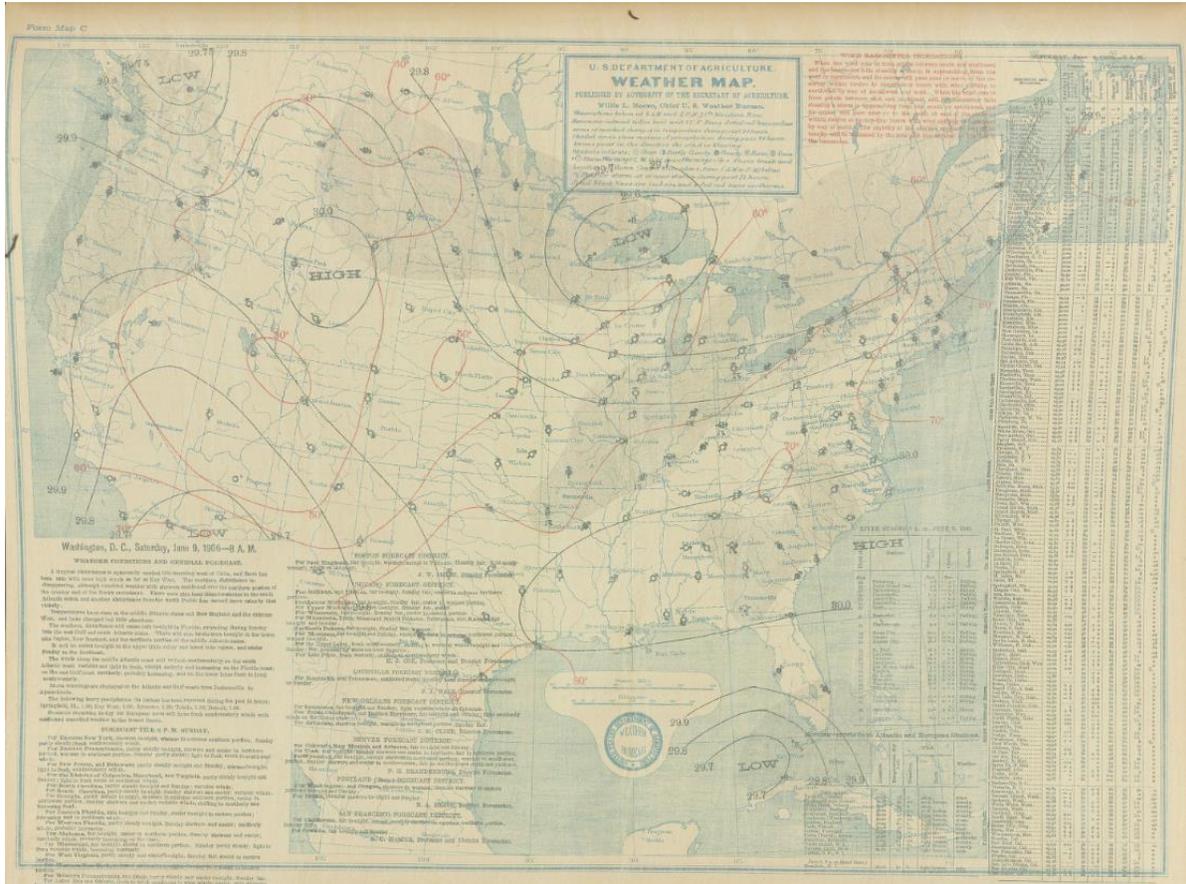
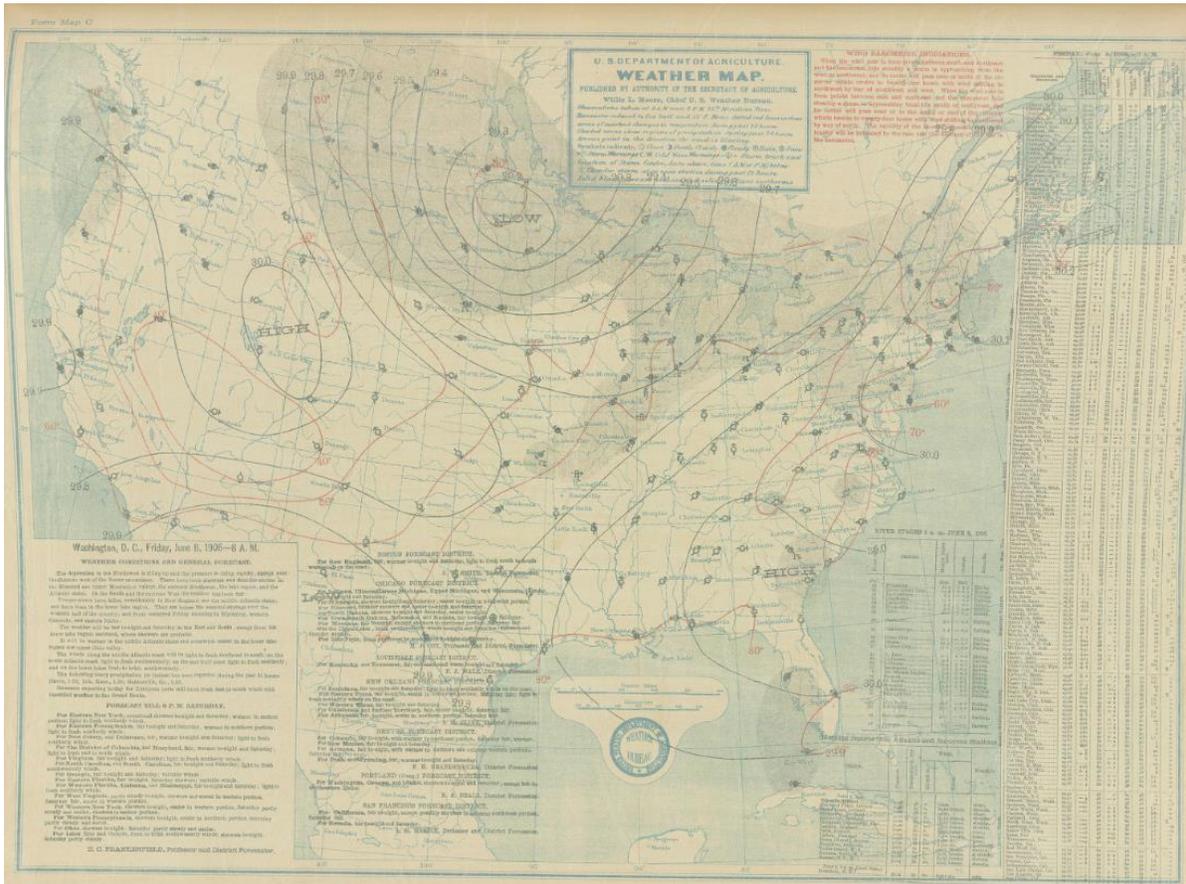


Table 5.1.--Representative persisting 12-hr 1000-mb storm and maximum dew points for important storms in and near study region

Storm No.	Name	Storm T _d			Ref. Old	Loc. New	Max. T _d		Stations
		Old	New	Date+			Old	New	
1.	Ward District, CO	62	64	30	325SE	350SE	75	77	AMA, DDC
6.	Boxelder, CO	60	60	4	350SE	320SE	72	74	DEN, PUB, DDC, OKC, ICT
8.	Rociada, NM	72	72	28	170SSE	300ESE	76	77	ABI, AMA
10.	Warrick, MT	64	64	6	380ESE	380ESE	73	75	ISN, PIR
13.	Evans, MT	65	65	4	510ESE	510ESE	75	76	BIS, RAP, PIR, VTN, HON
86.	May Valley, CO	67	67	18	450SSE	450SSE	76	76	AMA, ABI, FTW, SAT
20.	Clayton, NM	68	69	1	550SE	560SSE	76	77	SAT, DRT, CRP
23.	Tajique, NM	69	69	21	80SE	160SSE	77	78	ELP, ROW
25.	Lakewood, NM	-	76	7	-	350SE	-	79	DRT, SAT
27.	Meek, NM	72	72	15	390ESE	400ESE	78	79	AMA, ABI, FTW, OKC, SAT, GBK
30.	Fry's Ranch, CO	56	63	15	550ESE	700SE	71	74	FWH, DAL
31.	Penrose, CO	67	70	4	400SE	350SE	77	77	AMA, OKC
32.	Springbrook, MT	71	72	18	500ESE	370ESE	76	77	PIR, HON, FAR
35.	Virsylvania, NM (Cerro)	-	66	17	-	120SW	-	77	ABQ
38.	Savageton, WY	68	72	28	550SE	530SE	75	76	FRI, CNK
44.	Porter, NM	70	71	11	540SE	380SE	78	77	DRT, AUS, FTW, ABI
46.	Kassler, CO	71	66	10	440SE	420SE	77	77	OKC, DDC
47.	Cherry Creek, CO	72	71	30	540SE	560SE	76	79	ABI, ACT, FTW, SPS
101.	Hale, CO	72	71	30	540SE	560SE	76	79	ABI, ACT, FTW, SPS
48.	Las Cruces, NM*	-	71	30	-	-	-	78	ELP
105.	Broome, TX	77	77	14	350SSE	350SSE	78	80	CRP, BRO
53.	Loveland, CO	71	71	1	180SE	210SE	76	76	PUB, GLD
55.	Masonville, CO*	-	65	10	-	-	-	74	AKO
108.	Snyder, TX	73	75	19	100SE	340SSE	78	79	SAT, CRP
56.	Prairieview, NM	70	73	20	390SE	370SE	77	78	SAT, AUS
58.	McColleum Ranch, NM	72	72	21	50SE	300SE	77	79	ELP, DRT, SAT, CRP
60.	Rancho Grande, NM	74	75	31	250SE	250SE	77	78	LBB, BGS, ABI
66.	Ft. Collins, CO	66	67	30	570SE	600SE	78	78	GAG, TUL
67.	Golden, CO*	65	65	7	-	-	76	75	AMA

Note, this table is copied from HMR 55A and therefore units are in °F and miles.

Storm Precipitation Analysis System (SPAS) For Storm #1697_1

SPAS Analysis

General Storm Location: Ironwood, MI

Storm Dates: July 19-23, 1909

Event: Synoptic

DAD Zone 1

Latitude: 46.4542

Longitude: -90.2064

Max. Grid Rainfall Amount: 13.41"

Max. Observed Rainfall Amount: 13.21"

Number of Stations: 128

SPAS Version: 10.0

Base Map Used: PRISM_ppt_basemap_full

Spatial resolution: 0.2293

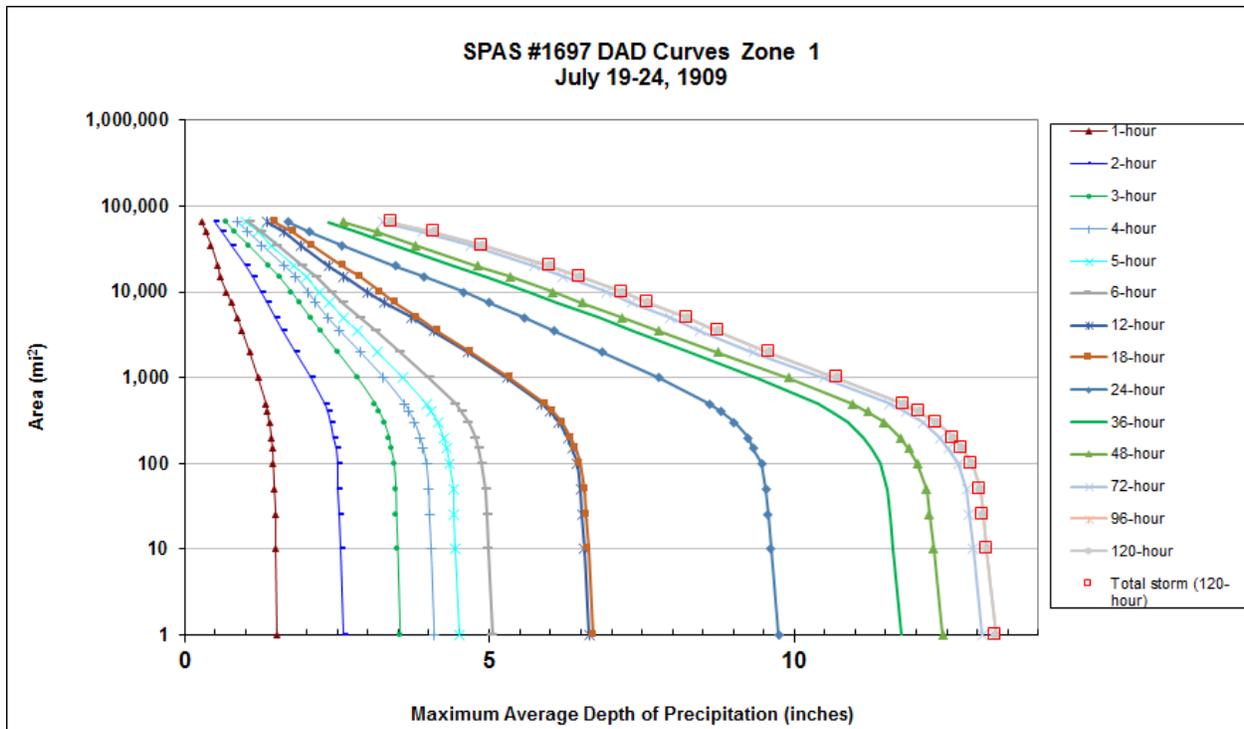
Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes

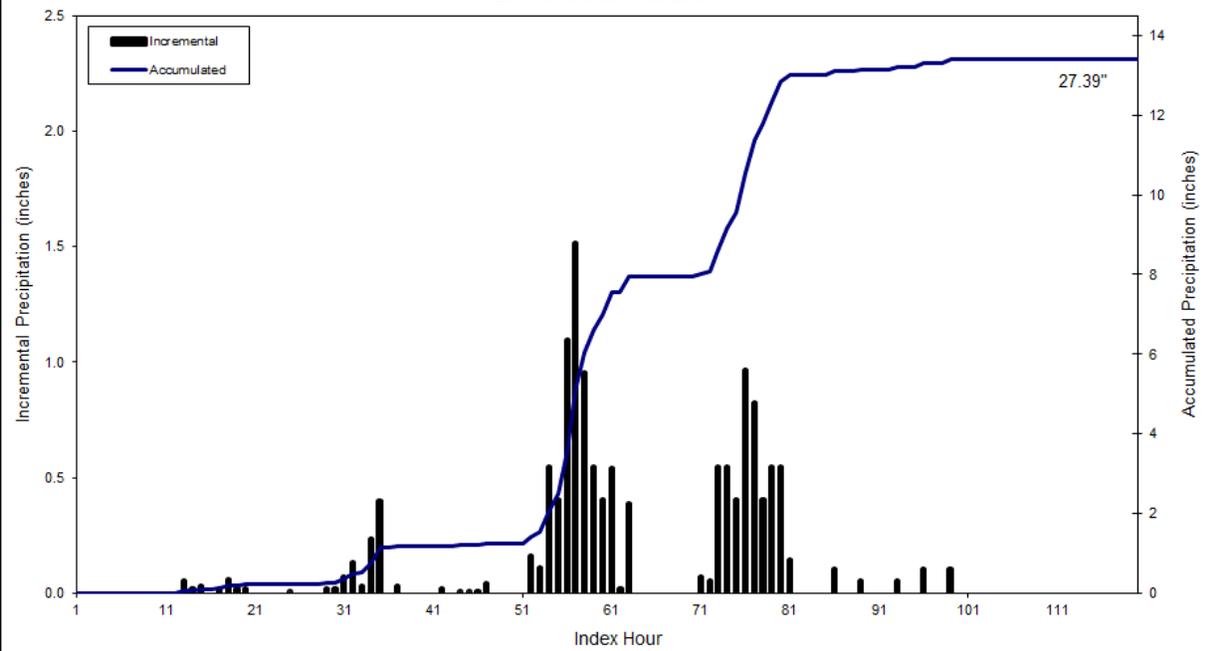
Reliability of Results: This analysis was based on 128 hourly pseudo stations, daily data and supplemental station data. We have a good degree of confidence for the station based storm total results. The spatial pattern is dependent on the PRISM basemap. Timing is based on the hourly pseudo stations. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

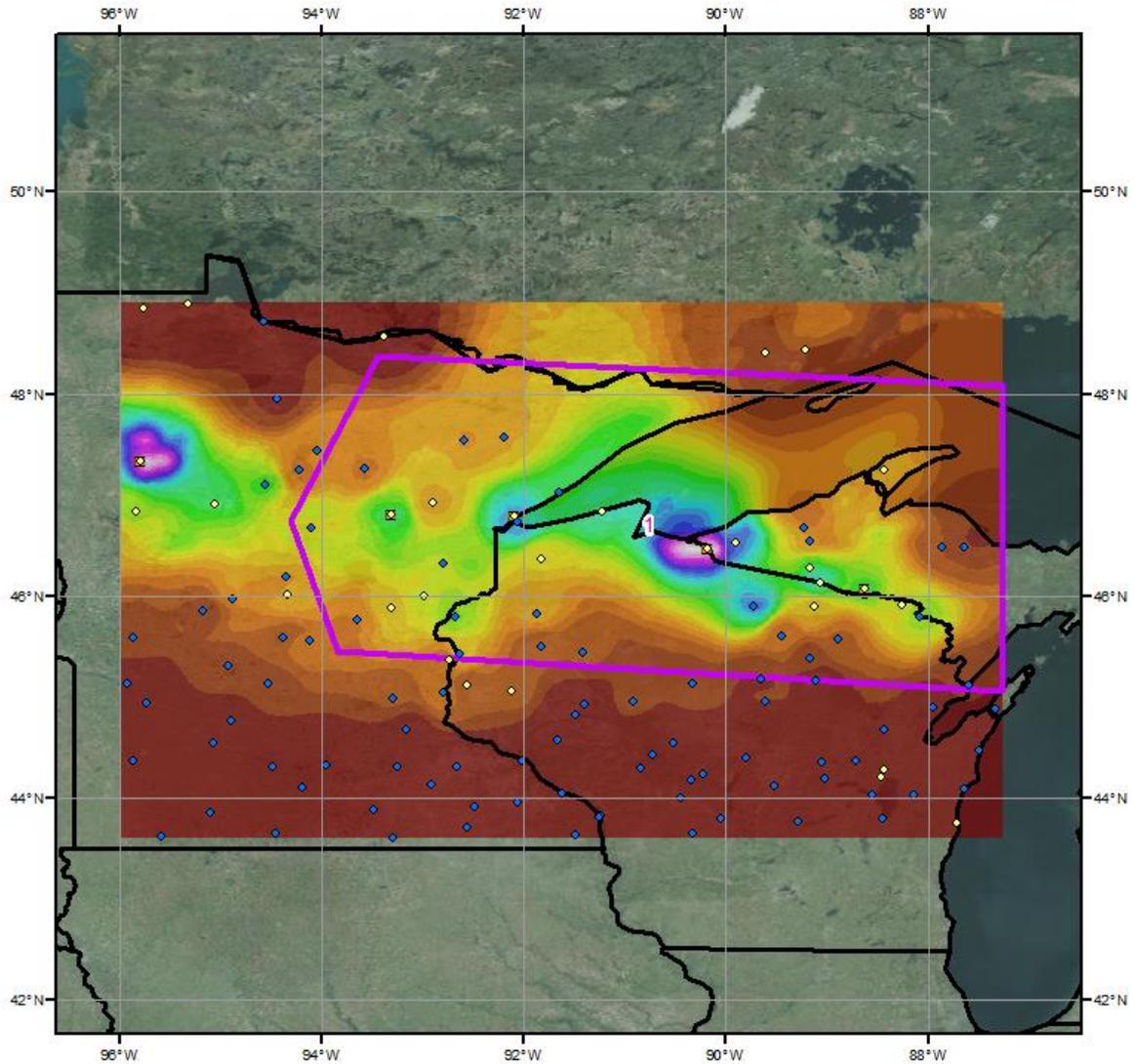
Storm 1697 - July 19 (0700 UTC) - July 24 (0600 UTC), 1909
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

Area (mi ²)	Duration (hours)													Total	
	1	2	3	4	5	6	12	18	24	36	48	72	96		120
0.4	1.51	2.61	3.55	4.11	4.51	5.06	6.67	6.73	9.79	11.81	12.49	13.14	13.37	13.37	13.37
1	1.51	2.59	3.53	4.09	4.50	5.04	6.63	6.70	9.74	11.76	12.44	13.08	13.31	13.31	13.31
10	1.49	2.55	3.49	4.04	4.44	4.98	6.55	6.62	9.62	11.62	12.28	12.93	13.16	13.16	13.16
25	1.49	2.53	3.47	4.01	4.42	4.96	6.52	6.59	9.57	11.57	12.22	12.87	13.10	13.10	13.10
50	1.47	2.52	3.46	4.00	4.41	4.94	6.50	6.57	9.54	11.53	12.17	12.83	13.05	13.05	13.05
100	1.45	2.51	3.43	3.96	4.34	4.87	6.44	6.48	9.46	11.40	12.02	12.69	12.91	12.91	12.91
150	1.44	2.48	3.38	3.91	4.30	4.82	6.36	6.41	9.33	11.26	11.88	12.53	12.75	12.75	12.75
200	1.42	2.45	3.35	3.86	4.24	4.76	6.29	6.33	9.24	11.13	11.74	12.39	12.61	12.61	12.61
300	1.39	2.39	3.27	3.77	4.15	4.65	6.14	6.19	9.01	10.88	11.47	12.11	12.33	12.33	12.33
400	1.35	2.34	3.19	3.68	4.05	4.54	5.99	6.04	8.80	10.62	11.20	11.83	12.04	12.04	12.04
500	1.33	2.29	3.12	3.60	3.96	4.44	5.86	5.91	8.61	10.38	10.95	11.57	11.79	11.79	11.79
1,000	1.20	2.07	2.83	3.26	3.58	4.01	5.29	5.34	7.78	9.40	9.91	10.49	10.69	10.69	10.69
2,000	1.06	1.82	2.50	2.87	3.17	3.54	4.65	4.70	6.86	8.29	8.74	9.33	9.58	9.58	9.58
3,500	0.94	1.61	2.23	2.54	2.83	3.14	4.08	4.15	6.07	7.36	7.78	8.46	8.73	8.74	8.74
5,000	0.86	1.48	2.06	2.34	2.61	2.88	3.72	3.81	5.57	6.78	7.17	7.96	8.23	8.23	8.23
7,500	0.76	1.35	1.88	2.14	2.37	2.60	3.28	3.45	5.00	6.11	6.52	7.33	7.60	7.60	7.60
10,000	0.68	1.25	1.75	2.01	2.21	2.41	2.99	3.21	4.58	5.62	6.04	6.92	7.18	7.18	7.18
15,000	0.58	1.12	1.55	1.81	2.00	2.15	2.61	2.87	3.92	4.90	5.33	6.21	6.47	6.47	6.47
20,000	0.54	1.00	1.38	1.63	1.80	1.94	2.36	2.59	3.46	4.42	4.80	5.74	5.97	5.99	5.99
35,000	0.43	0.76	1.05	1.26	1.42	1.52	1.90	2.08	2.57	3.43	3.78	4.68	4.87	4.88	4.88
50,000	0.34	0.61	0.82	1.03	1.20	1.26	1.63	1.78	2.05	2.84	3.17	3.91	4.07	4.08	4.08
65,546	0.28	0.49	0.68	0.85	1.00	1.06	1.36	1.48	1.70	2.36	2.61	3.24	3.37	3.38	3.38



SPAS1697 Storm Center Mass Curve: Zone 1
July 19 (0700 UTC) - July 24 (0600 UTC), 1909
Lat: 46.4542 Lon: -90.2064

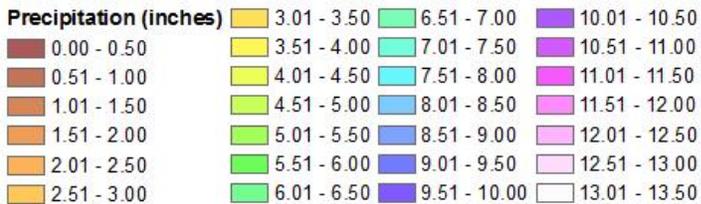
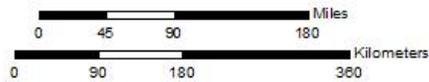




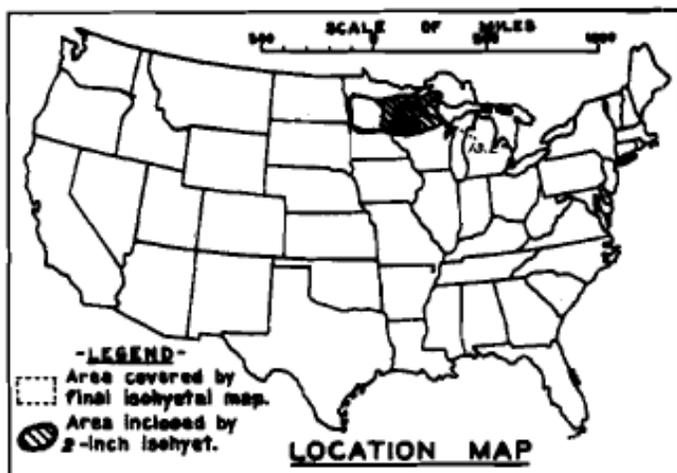
Total Storm (120-hours) Precipitation (inches)
July 19-23, 1909
SPAS 1697 - Ironwood, MI

Gauges

- ◆ Daily
- Hourly
- HE
- Hourly Pseudo
- ◇ Supplemental



STORM STUDIES - PERTINENT DATA SHEET (REV.)



Storm of 18-23 July 1909
 Assignment UMV 1-11 (b)
 Location Northern Minn. & Wis.
 Study Prepared by:
 Upper Mississippi Valley
 Division
 St. Paul District Office

Part I Reviewed by H. M. Sec. of
 Weather Bureau, 6/7/39
 Part II Approved by Office, Chief
 of Engineers for Distribution
 of Factual Data, 5/24/41

Remarks: Rainfall Data only
 for Ironwood, Mich. center
 Dewpt. 70° - Ref. Pt. 275 SSW
 Grid B-12

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000

Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)-----	4
Form 5001-B (24-hour " " " ")-----	-
Form 5001-D (" " " " ")-----	8
Misc. precip. records, meteorological data, etc.-----	1
Form 5002 (Mass rainfall curves)-----	24

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000

Data and computation sheets:

Form S-10 (Data from mass rainfall curves)-----	4
Form S-11 (Depth-area data from isohyetal map)-----	2
Form S-12 (Maximum depth-duration data)-----	8
Maximum duration-depth-area curves-----	2
Data relating to periods of maximum rainfall-----	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

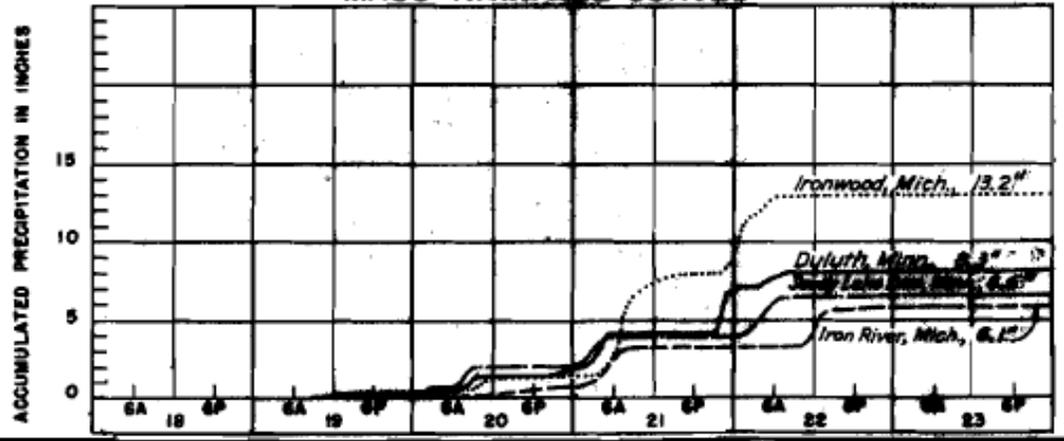
Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	108
10	5.2	6.3	6.7	9.6	11.1	11.7	12.1	12.8	13.2	13.2	13.2
100	5.1	6.2	6.6	9.4	10.8	11.4	11.8	12.5	12.9	12.9	12.9
200	4.6	6.0	6.3	9.0	10.5	11.1	11.5	12.1	12.5	12.5	12.5
500	3.9	5.5	5.8	7.9	9.8	10.1	10.7	11.2	11.5	11.5	11.5
1,000	3.2	5.0	5.3	6.9	9.0	9.3	9.7	10.3	10.5	10.5	10.5
2,000	2.8	4.4	4.6	6.0	7.9	8.2	8.7	9.2	9.5	9.5	9.5
5,000	2.3	3.6	3.8	5.0	6.5	6.8	7.2	7.8	8.0	8.0	8.0
10,000	2.1	3.2	3.4	4.2	5.4	5.6	6.0	6.5	6.7	6.9	6.9

STORM STUDIES - ISOHYETAL MAP

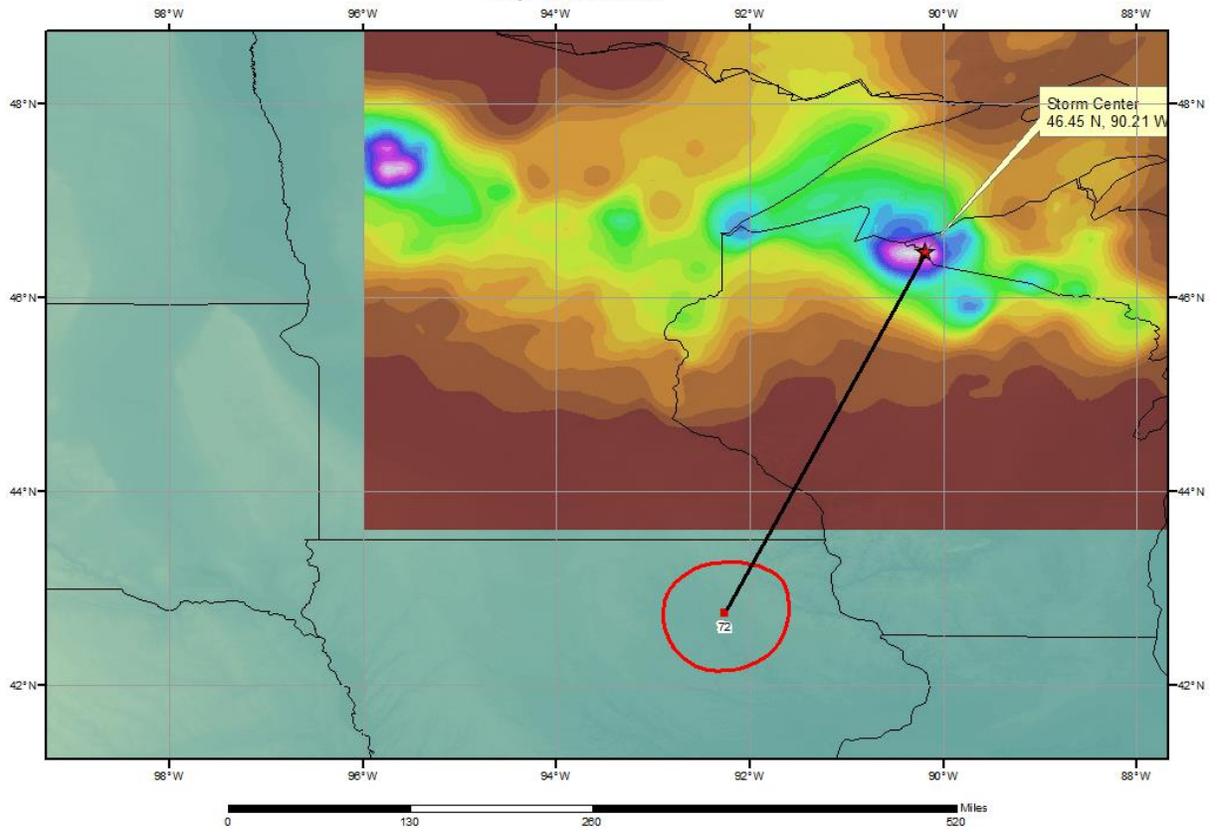
Storm of July 18-23, 1909 Assignment UMV 1-11 (b)
Study Prepared by: St. Paul, Minn. District
Upper Mississippi Valley Division



MASS RAINFALL CURVES



SPAS 1697 Ironwood, MI Storm Analysis (UMV 1-11B)
July 18-23, 1909



Storm Precipitation Analysis System (SPAS) For Storm #1336_1

SPAS Analysis

General Storm Location: Springbrook, Montana

Storm Dates: June 17-21, 1921

Event: Mid-latitude cyclone

DAD Zone 1

Latitude: 47.3642°

Longitude: -105.7778°

Max. grid rainfall amount: 386mm

Max. observed rainfall amount: 383mm (SPRINGBROOK MT)

Number of Stations: 98

SPAS Version: 9.5

Base Map Used: Based on digitized HMR 55A Isohyetal Map (storm total)

Spatial resolution: 30 seconds (degree: minute: second, WGS84, ~ 0.3 mi², 0.78 km²)

Radar Included: No

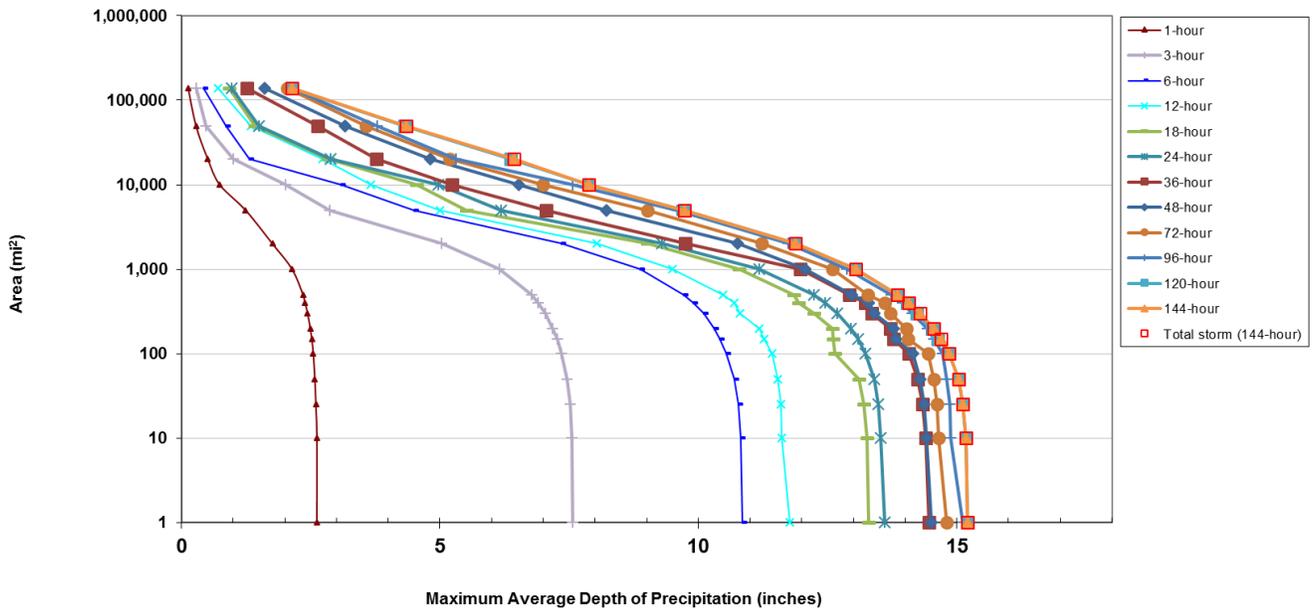
Depth-Area-Duration (DAD) analysis: Yes

Reliability of Results: There were no digitized hourly data available, so hourly data for the five stations used in the analysis were derived from mass curves in the USACE report. Because of the nature of the data, DAD results for shorter than 6-hours may be less reliable (previous studies do not provide results for less than 6 hours). That said, the DAD results for 6 hour and longer are consistent with those from HMR55A and USACE. Because there are very few stations located near the center of the storm, confidence is low regarding the spatial pattern near the center but storm magnitudes are reliable.

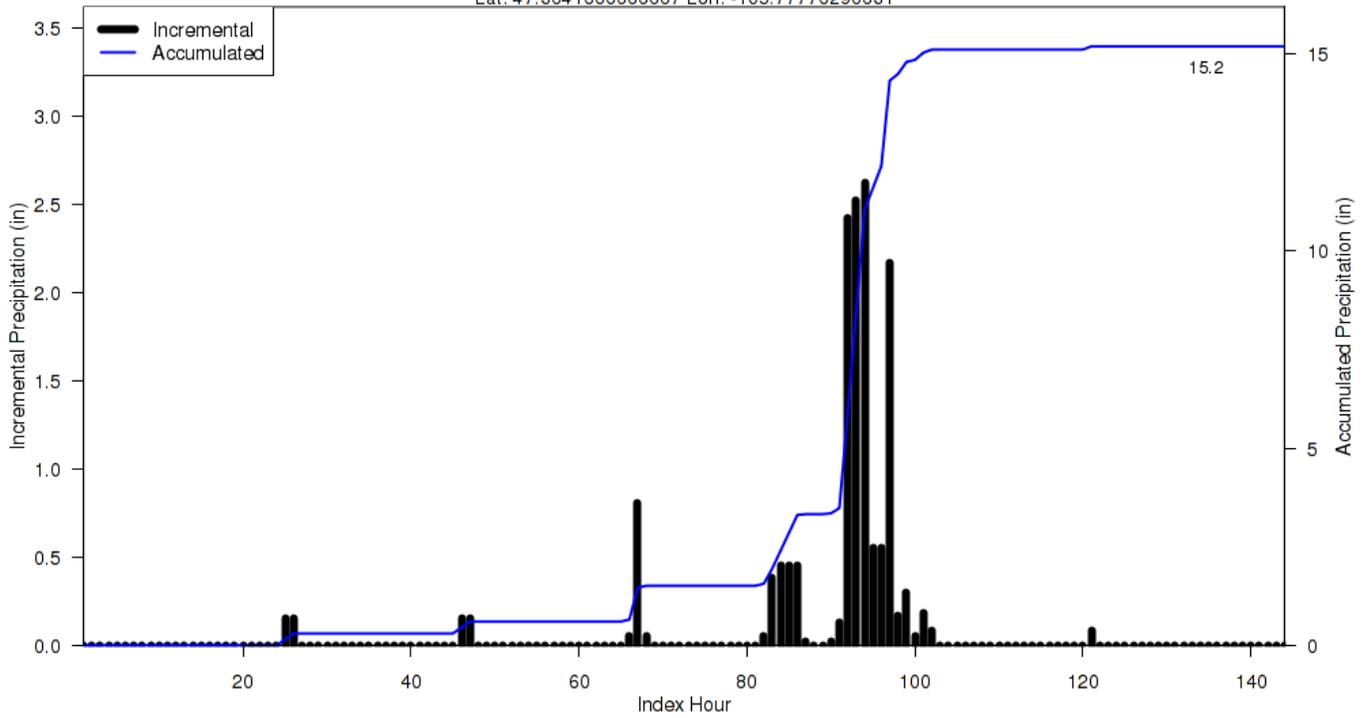
SPAS 1336 - June 16 (0800 UTC) - June 22 (0700 UTC), 1921
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

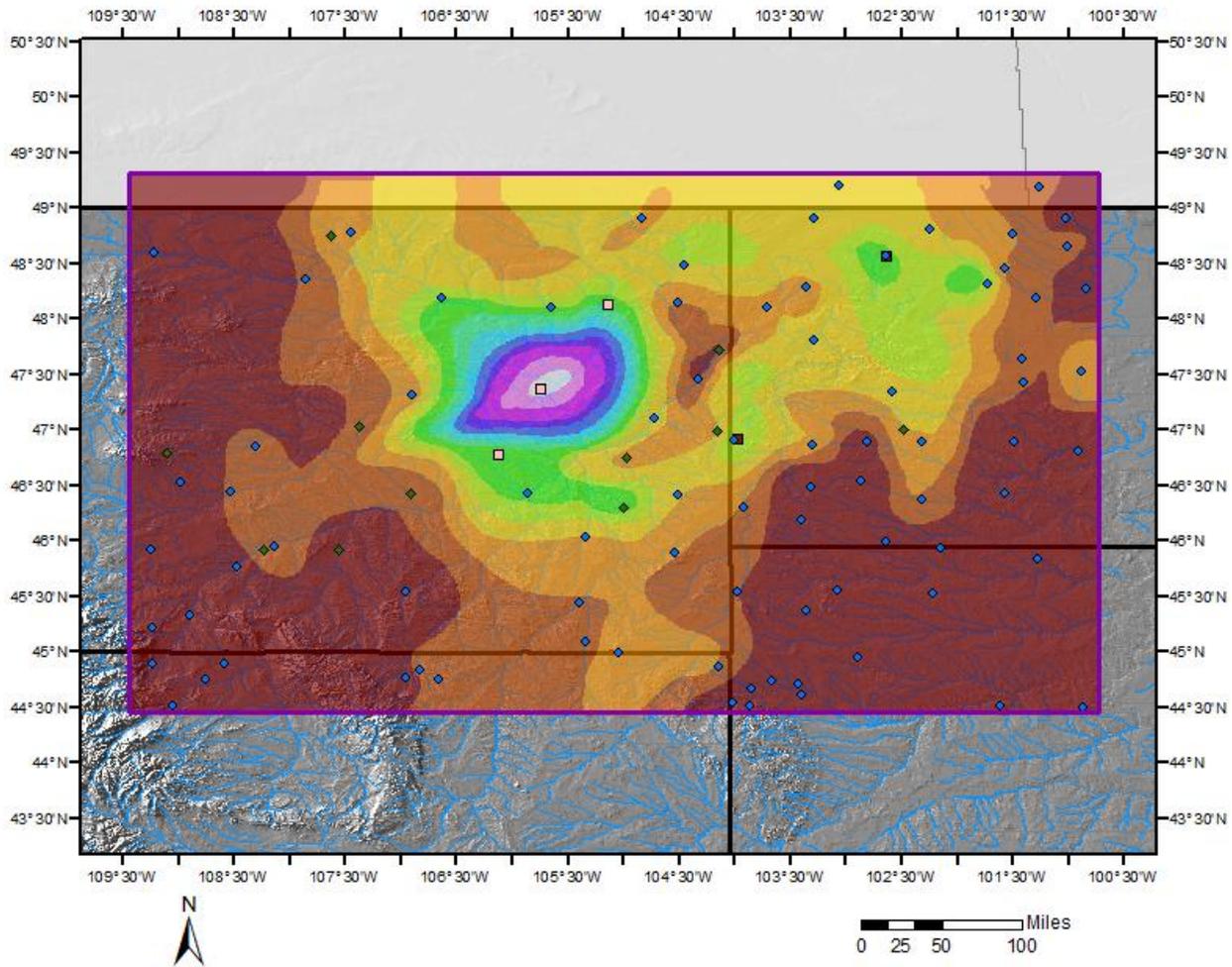
Area (mi ²)	Duration (hours)												
	1	3	6	12	18	24	36	48	72	96	120	144	Total
0.2	2.62	7.57	10.85	11.77	13.29	13.60	14.46	14.51	14.81	15.11	15.20	15.20	15.20
1	2.62	7.57	10.85	11.77	13.29	13.60	14.46	14.51	14.81	15.11	15.20	15.20	15.20
10	2.62	7.55	10.82	11.62	13.26	13.52	14.40	14.41	14.64	14.88	15.17	15.17	15.17
25	2.60	7.52	10.77	11.59	13.20	13.48	14.34	14.36	14.61	14.86	15.12	15.12	15.12
50	2.58	7.46	10.69	11.54	13.11	13.40	14.25	14.29	14.55	14.81	15.03	15.03	15.03
100	2.55	7.35	10.54	11.42	12.64	13.23	14.07	14.15	14.44	14.73	14.85	14.85	14.85
150	2.52	7.27	10.42	11.27	12.61	13.09	13.78	13.82	14.06	14.55	14.63	14.70	14.70
200	2.49	7.18	10.30	11.17	12.59	12.95	13.71	13.77	14.02	14.43	14.52	14.55	14.55
300	2.44	7.04	10.10	10.80	12.24	12.69	13.36	13.40	13.72	14.14	14.22	14.29	14.29
400	2.39	6.90	9.90	10.70	11.94	12.46	13.23	13.30	13.60	13.94	14.04	14.07	14.07
500	2.35	6.77	9.72	10.47	11.85	12.24	12.92	12.97	13.28	13.73	13.86	13.86	13.86
1,000	2.14	6.16	8.88	9.49	10.79	11.18	11.97	12.07	12.59	12.88	13.04	13.04	13.04
2,000	1.76	5.03	7.35	8.03	9.01	9.29	9.74	10.75	11.23	11.74	11.88	11.88	11.88
5,000	1.24	2.87	4.50	5.00	5.52	6.19	7.06	8.22	9.02	9.59	9.73	9.73	9.73
10,000	0.74	2.01	3.09	3.67	4.55	4.97	5.24	6.52	7.00	7.57	7.88	7.88	7.88
20,000	0.51	1.01	1.31	2.73	2.84	2.89	3.77	4.81	5.18	5.31	6.37	6.44	6.44
50,000	0.28	0.47	0.87	1.34	1.42	1.50	2.63	3.17	3.57	3.79	4.31	4.35	4.35
138,316	0.13	0.28	0.42	0.71	0.92	0.97	1.26	1.61	2.04	2.12	2.14	2.14	2.14

SPAS #1336 DAD Curves Zone 1
June 16-22, 1921



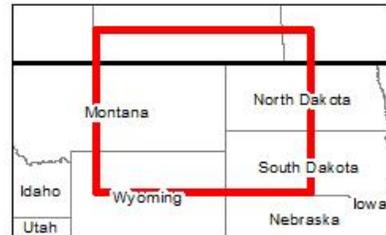
SPAS 1336 Storm Center Mass Curve Zone 1
June 16 (0800UTC) to June 22 (0700UTC), 1921
Lat: 47.3641666666667 Lon: -105.77776290631



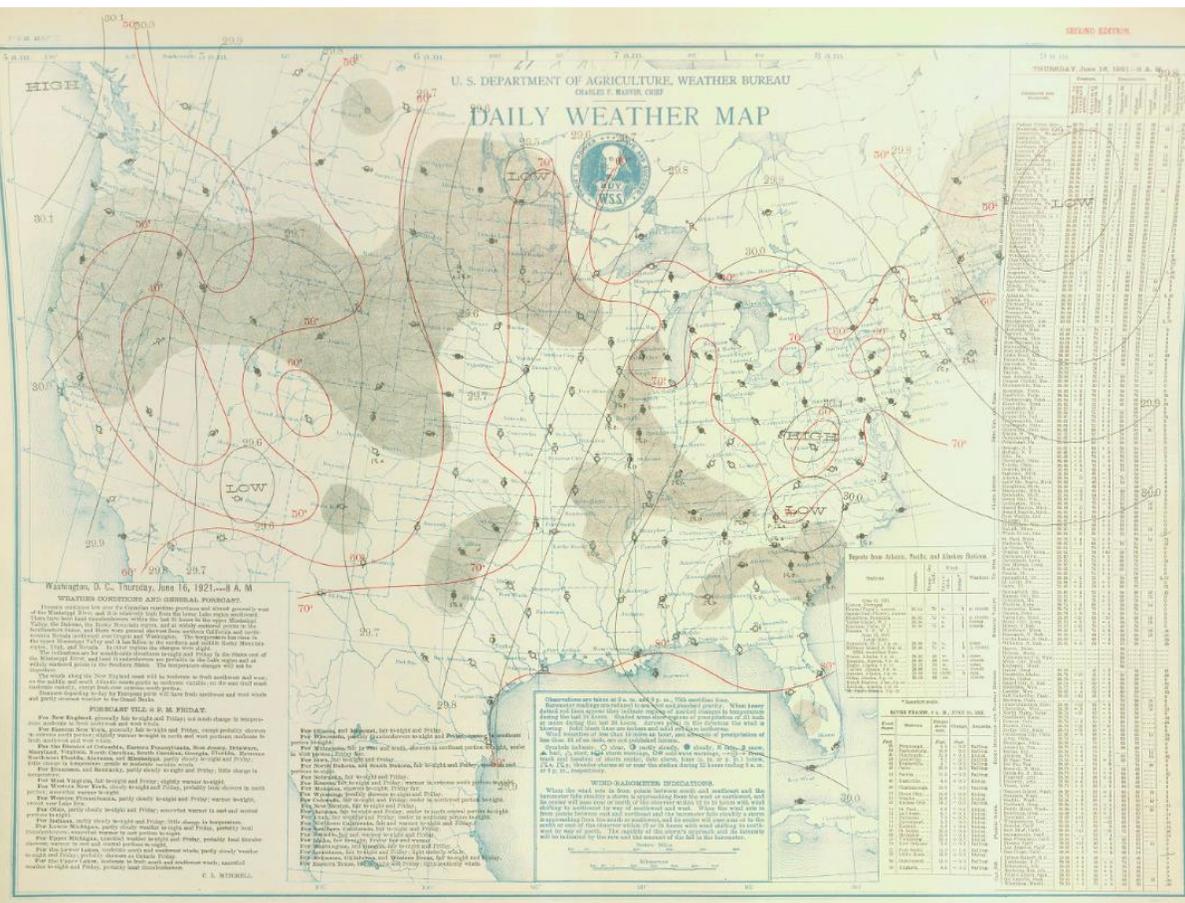


Total 96-hr Precipitation (inches)
June 16, 1921 0800 UTC - June 21, 1921 0800 UTC
SPAS #1336

Precipitation (inches)		Stations
0.00 - 1.00	7.01 - 8.00	◆ Daily
1.01 - 2.00	8.01 - 9.00	□ Hourly Estimated
2.01 - 3.00	9.01 - 10.00	■ Hourly Estimated Pseudo
3.01 - 4.00	10.01 - 12.00	◆ Supplemental
4.01 - 5.00	12.01 - 14.00	
5.01 - 6.00	14.01 - 16.00	
6.01 - 7.00		



U.S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU
DAILY WEATHER MAP



Washington, D. C., Thursday, June 16, 1921—8 A.M.

WEATHER CONDITIONS AND GENERAL FORECAST

The high pressure system over the Pacific Northwest... The low pressure system over the Gulf of Mexico... The weather conditions are generally... The forecast for the next 24 hours is...

FORECAST TILL 5 P. M. FRIDAY

The high pressure system... The low pressure system... The weather conditions are generally... The forecast for the next 24 hours is...

WEATHER SERVICE

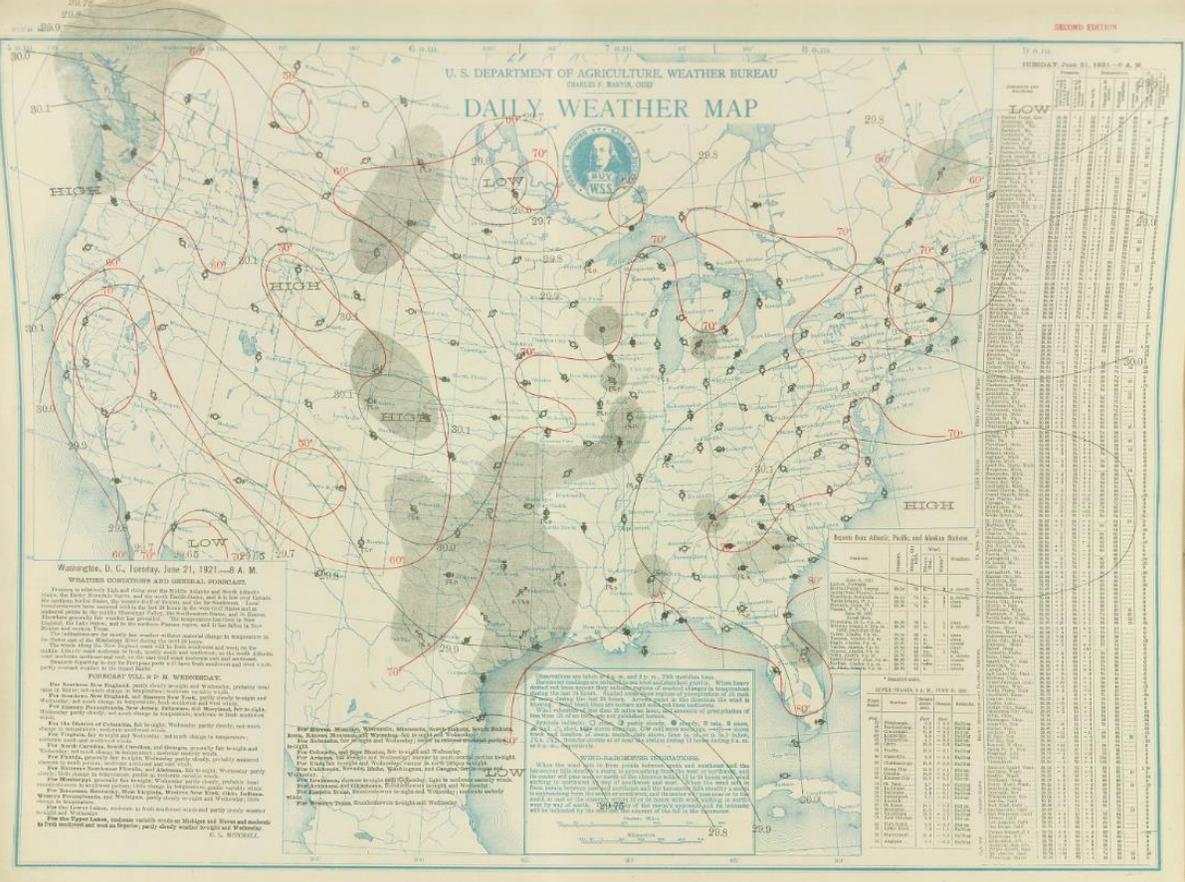
Observations are taken at 8 A. M., 11 A. M., 2 P. M., 5 P. M., and 8 P. M. on the weather map. The observations are taken at the following stations:...

REPORTS FROM STATIONS, PORTS, AND SHIPBOARD OBSERVATIONS

Table with multiple columns for station names, coordinates, and weather observations. Includes a section for 'STATION REPORTS' and 'SHIPBOARD OBSERVATIONS'.

Large table on the right side of the map, likely containing station data, weather records, or administrative information. It has many columns and rows of text.

U. S. DEPARTMENT OF AGRICULTURE WEATHER BUREAU
DAILY WEATHER MAP



Washington, D. C., Tuesday, June 21, 1921.—8 A. M.

WEATHER CONDITIONS AND GENERAL REMARKS.

Pressure in vicinity 1014 and rising over the States; slight and steady increase over the West; moderate and steady increase over the South; slight and steady increase over the East. Low temperatures have cooled over the East; low in the West; slight and steady increase over the South. The temperature has risen a few degrees in the West, and in the South; slight and steady increase over the East.

Temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

Relative humidity over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

For the States, moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

For the States, moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

For the States, moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

For the States, moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

For the States, moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

For the States, moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

For the States, moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

Temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

Temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

Temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

Temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

Temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

Report from Atlantic, Pacific, and Alaska Stations

Table with columns for Station, Date, Time, and various weather observations (Wind, Clouds, Visibility, etc.).

Table with columns for Station, Date, Time, and various weather observations (Wind, Clouds, Visibility, etc.).

When the wind has been steady between North and South, the temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

When the wind has been steady between North and South, the temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

When the wind has been steady between North and South, the temperature over the States has moderate and steady increase in the West; slight and steady increase over the South; slight and steady increase over the East. Windy and steady increase over the West; slight and steady increase over the South; slight and steady increase over the East.

Table 5.1.--Representative persisting 12-hr 1000-mb storm and maximum dew points for important storms in and near study region

Storm No.	Name	Storm T _d			Ref. Old	Loc. New	Max. T _d		Stations
		Old	New	Date+			Old	New	
1.	Ward District, CO	62	64	30	325SE	350SE	75	77	AMA, DDC
6.	Boxelder, CO	60	60	4	350SE	320SE	72	74	DEN, PUB, DDC, OKC, ICT
8.	Rociada, NM	72	72	28	170SSE	300ESE	76	77	ABI, AMA
10.	Warrick, MT	64	64	6	380ESE	380ESE	73	75	ISN, PIR
13.	Evans, MT	65	65	4	510ESE	510ESE	75	76	BIS, RAP, PIR, VTN, HON
86.	May Valley, CO	67	67	18	450SSE	450SSE	76	76	AMA, ABI, FTW, SAT
20.	Clayton, NM	68	69	1	550SE	560SSE	76	77	SAT, DRT, CRP
23.	Tajique, NM	69	69	21	80SE	160SSE	77	78	ELP, ROW
25.	Lakewood, NM	-	76	7	-	350SE	-	79	DRT, SAT
27.	Meek, NM	72	72	15	390ESE	400ESE	78	79	AMA, ABI, FTW, OKC, SAT, GBK
30.	Fry's Ranch, CO	56	63	15	550ESE	700SE	71	74	FWH, DAL
31.	Penrose, CO	67	70	4	400SE	350SE	77	77	AMA, OKC
32.	Springbrook, MT	71	72	18	500ESE	370ESE	76	77	PIR, HON, FAR
35.	Virsylvania, NM (Cerro)	-	66	17	-	120SW	-	77	ABQ
38.	Savageton, WY	68	72	28	550SE	530SE	75	76	FRI, CNK
44.	Porter, NM	70	71	11	540SE	380SE	78	77	DRT, AUS, FTW, ABI
46.	Kassler, CO	71	66	10	440SE	420SE	77	77	OKC, DDC
47.	Cherry Creek, CO	72	71	30	540SE	560SE	76	79	ABI, ACT, FTW, SPS
101.	Hale, CO	72	71	30	540SE	560SE	76	79	ABI, ACT, FTW, SPS
48.	Las Cruces, NM*	-	71	30	-	-	-	78	ELP
105.	Broome, TX	77	77	14	350SSE	350SSE	78	80	CRP, BRO
53.	Loveland, CO	71	71	1	180SE	210SE	76	76	PUB, GLD
55.	Masonville, CO*	-	65	10	-	-	-	74	AKO
108.	Snyder, TX	73	75	19	100SE	340SSE	78	79	SAT, CRP
56.	Prairieview, NM	70	73	20	390SE	370SE	77	78	SAT, AUS
58.	McColleum Ranch, NM	72	72	21	50SE	300SE	77	79	ELP, DRT, SAT, CRP
60.	Rancho Grande, NM	74	75	31	250SE	250SE	77	78	LBB, BGS, ABI
66.	Ft. Collins, CO	66	67	30	570SE	600SE	78	78	GAG, TUL
67.	Golden, CO*	65	65	7	-	-	76	75	AMA

Note, this table is copied from HMR 55A and therefore units are in °F and miles.

Storm Precipitation Analysis System (SPAS) For Storm #1325_1

SPAS Analysis

General Storm Location: Savageton, Wyoming

Storm Dates: Sept. 27-Oct. 1, 1923

Event: Mid-latitude cyclone

DAD Zone 1

Latitude: 43.8458°

Longitude: -105.8042°

Max. grid rainfall amount: 446mm

Max. observed rainfall amount: 434mm (SAVAGETON WY)

Number of Stations: 111

SPAS Version: 9.5

Base Map Used: Based on digitized HMR Isohyetal Map (storm total Sept. 27-Oct. 1, 1923) and PRISM Sept/Oct monthly mean maps

Spatial resolution: 30 seconds (degree: minute: second, WGS84, ~ 0.3 mi², 0.78 km²)

Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes

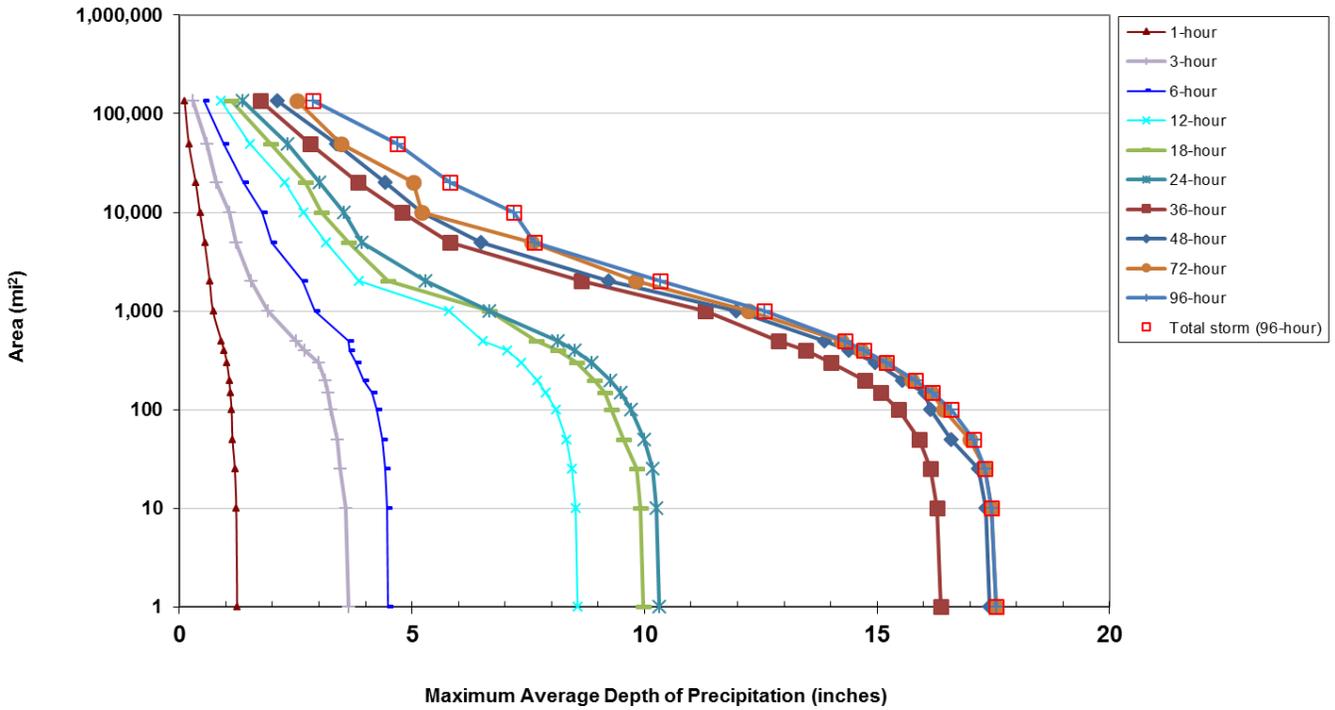
Reliability of Results: The complex terrain and limited number of hourly and daily data near the primary small storm center diminish the reliability of these results. In particular, there were only 5 hourly stations and their hourly data were estimated from USACE's smoothed mass rainfall curves. We theorize that the hourly data at these storm centers were estimated by USBR based on information (non-gauge data) available to them at the time. However, given this was a synoptic storm with large areas of nearly continuous precipitation (rainfall), it's believed the temporal distribution of precipitation is fairly reliable. The use of the U.S. Army Corps of Engineers' isohyetal pattern coupled with the monthly mean maps for September and October provides some confidence in the spatial patterns and magnitudes of precipitation. Lastly, orographic effects (accounted for in the PRISM maps) have created a maxima in the grid (17.56") that is slightly higher than the maximum observed at a station (17.10") in the storm center; the effect at the storm center was constrained by editing the basemap.

SPAS 1325 - September 26 (0800 UTC) - October 2 (0700 UTC), 1923

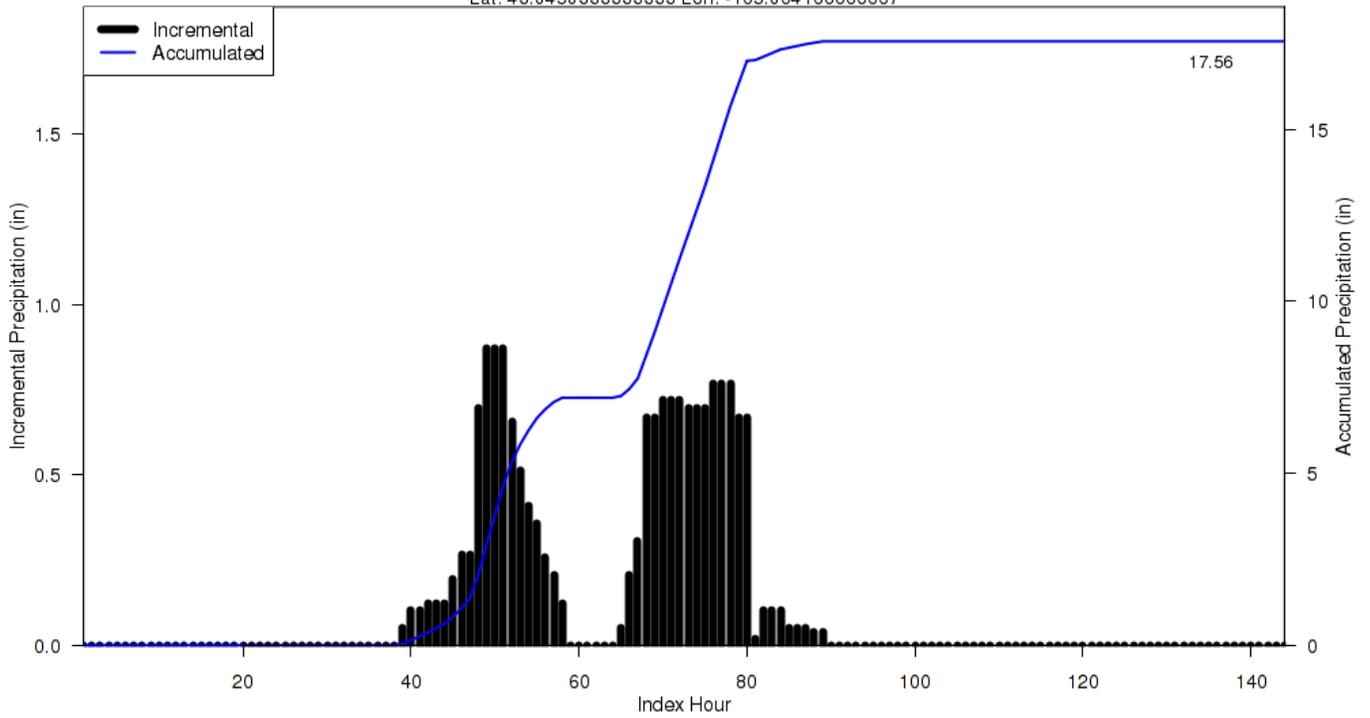
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

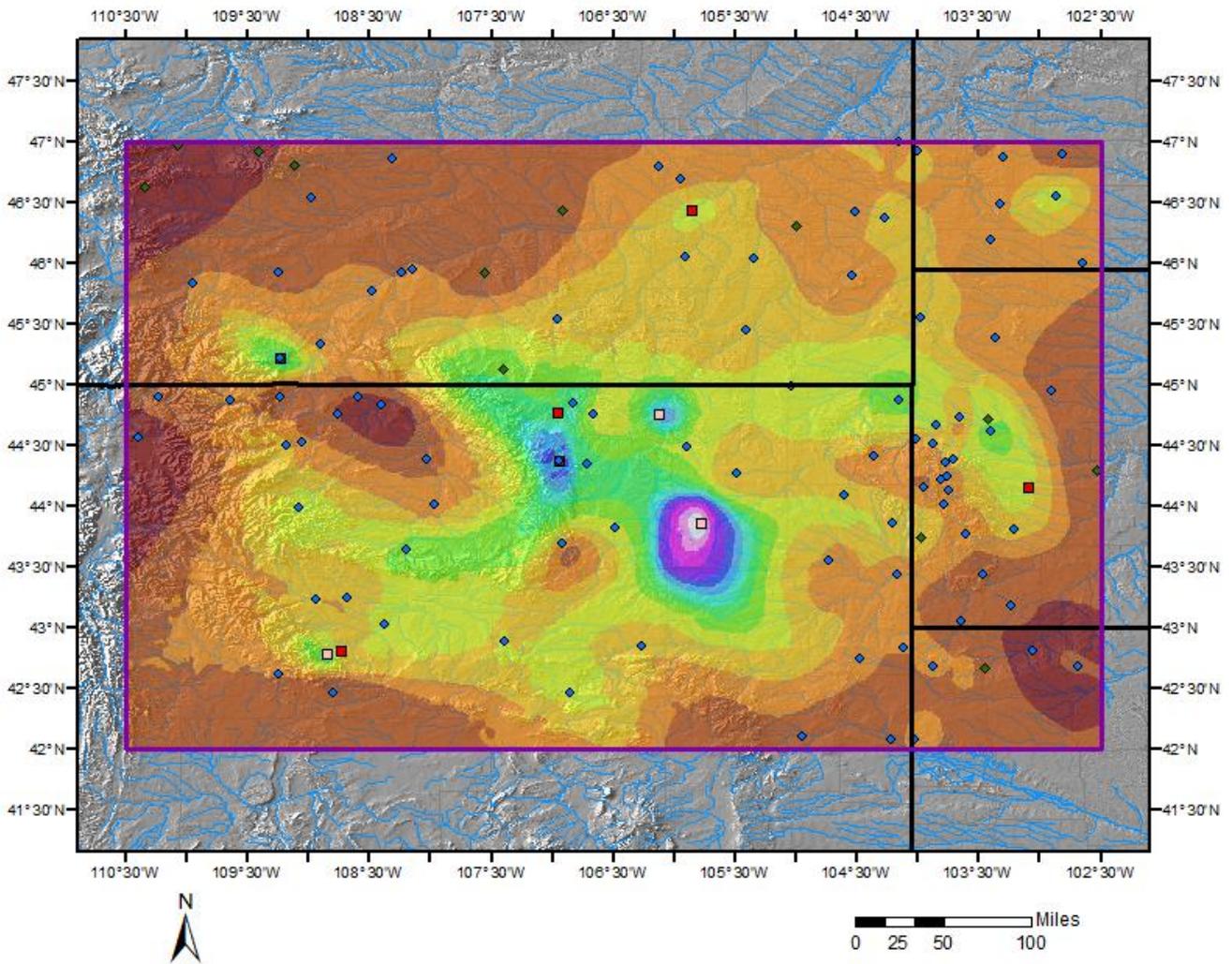
Area (mi ²)	Duration (hours)										
	1	3	6	12	18	24	36	48	72	96	Total
0.2	1.24	3.65	4.59	8.56	9.97	10.32	16.37	17.43	17.56	17.56	17.56
1	1.24	3.64	4.49	8.56	9.97	10.32	16.36	17.42	17.55	17.55	17.55
10	1.22	3.57	4.47	8.52	9.92	10.26	16.28	17.33	17.46	17.46	17.46
25	1.19	3.46	4.43	8.44	9.83	10.17	16.14	17.18	17.31	17.31	17.31
50	1.14	3.39	4.36	8.32	9.55	9.99	15.91	16.60	16.99	17.07	17.07
100	1.12	3.26	4.24	8.09	9.28	9.71	15.47	16.14	16.43	16.60	16.60
150	1.09	3.20	4.14	7.88	9.15	9.49	15.08	16.03	16.17	16.19	16.19
200	1.07	3.13	3.96	7.69	8.92	9.26	14.73	15.55	15.74	15.83	15.83
300	1.02	2.98	3.80	7.35	8.54	8.86	14.00	14.96	15.18	15.20	15.20
400	0.96	2.69	3.66	7.05	8.13	8.49	13.46	14.40	14.66	14.71	14.71
500	0.90	2.50	3.63	6.53	7.67	8.14	12.88	13.87	14.23	14.32	14.32
1,000	0.72	1.91	2.91	5.79	6.66	6.66	11.31	11.97	12.24	12.58	12.58
2,000	0.65	1.53	2.65	3.86	4.48	5.30	8.63	9.22	9.81	10.34	10.34
5,000	0.54	1.21	1.99	3.16	3.64	3.92	5.82	6.48	7.57	7.64	7.64
10,000	0.44	1.08	1.77	2.66	3.05	3.53	4.78	5.20	5.20	7.19	7.19
20,000	0.35	0.79	1.37	2.26	2.71	3.01	3.83	4.43	5.02	5.81	5.81
50,000	0.20	0.58	0.96	1.52	1.97	2.32	2.81	3.37	3.47	4.69	4.69
136,442	0.11	0.29	0.52	0.90	1.12	1.35	1.74	2.11	2.52	2.87	2.87

**SPAS #1325 DAD Curves Zone 1
September 26 - October 2, 1923**



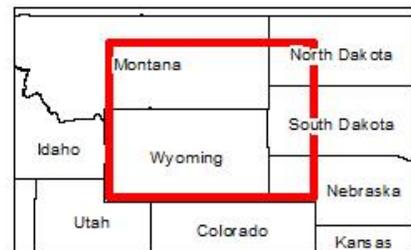
SPAS 1325 Storm Center Mass Curve Zone 1
September 26 (0800UTC) to October 2 (0700UTC), 1923
Lat: 43.84583333333333 Lon: -105.804166666667

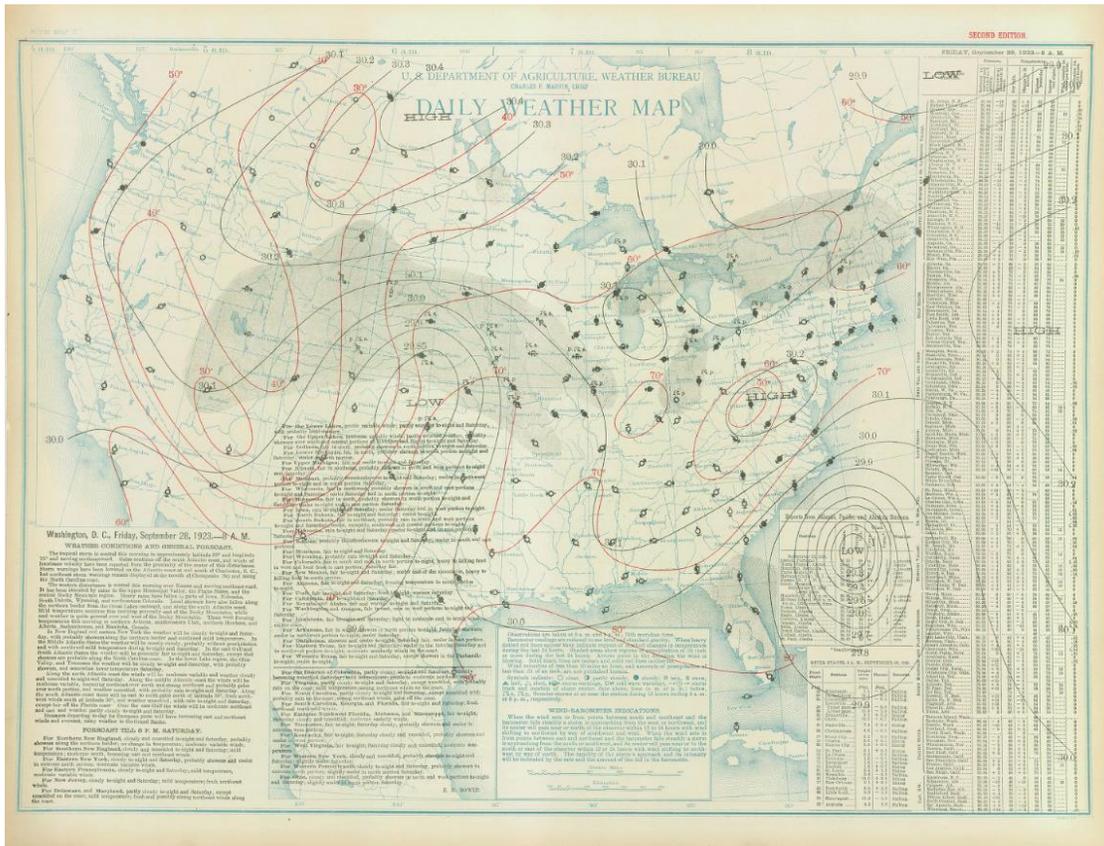
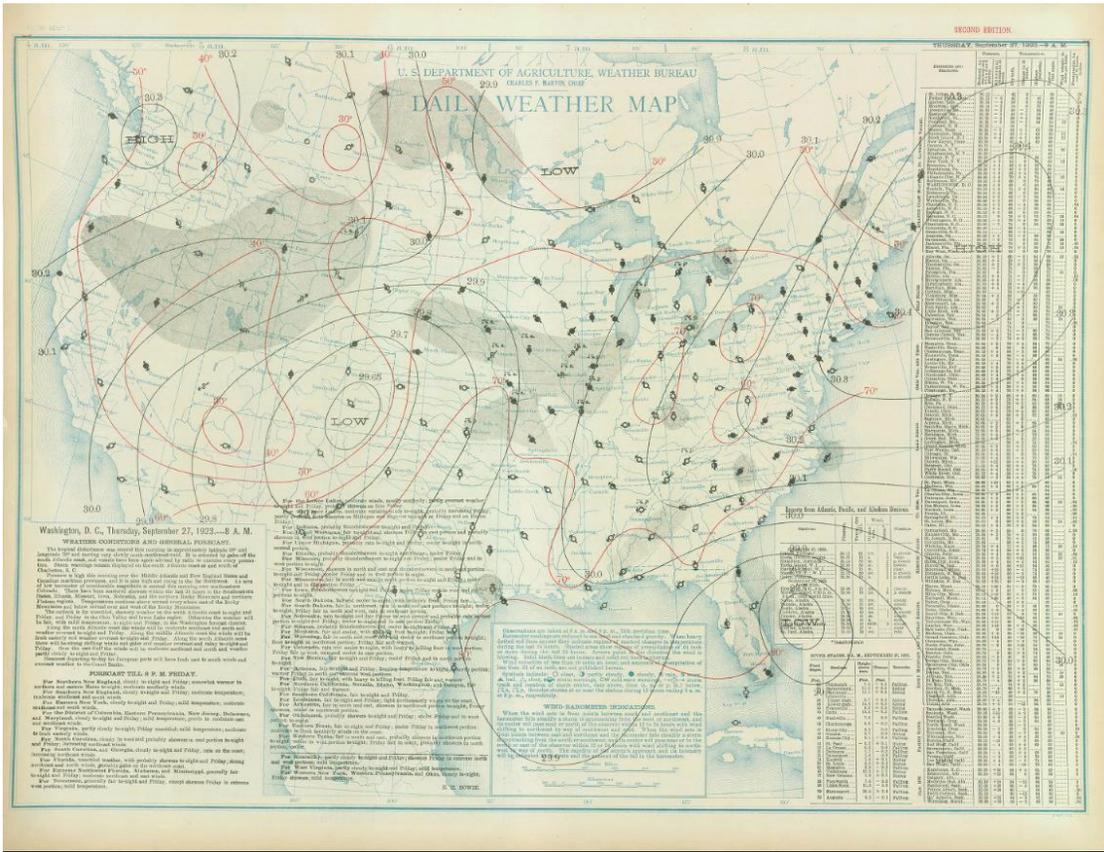


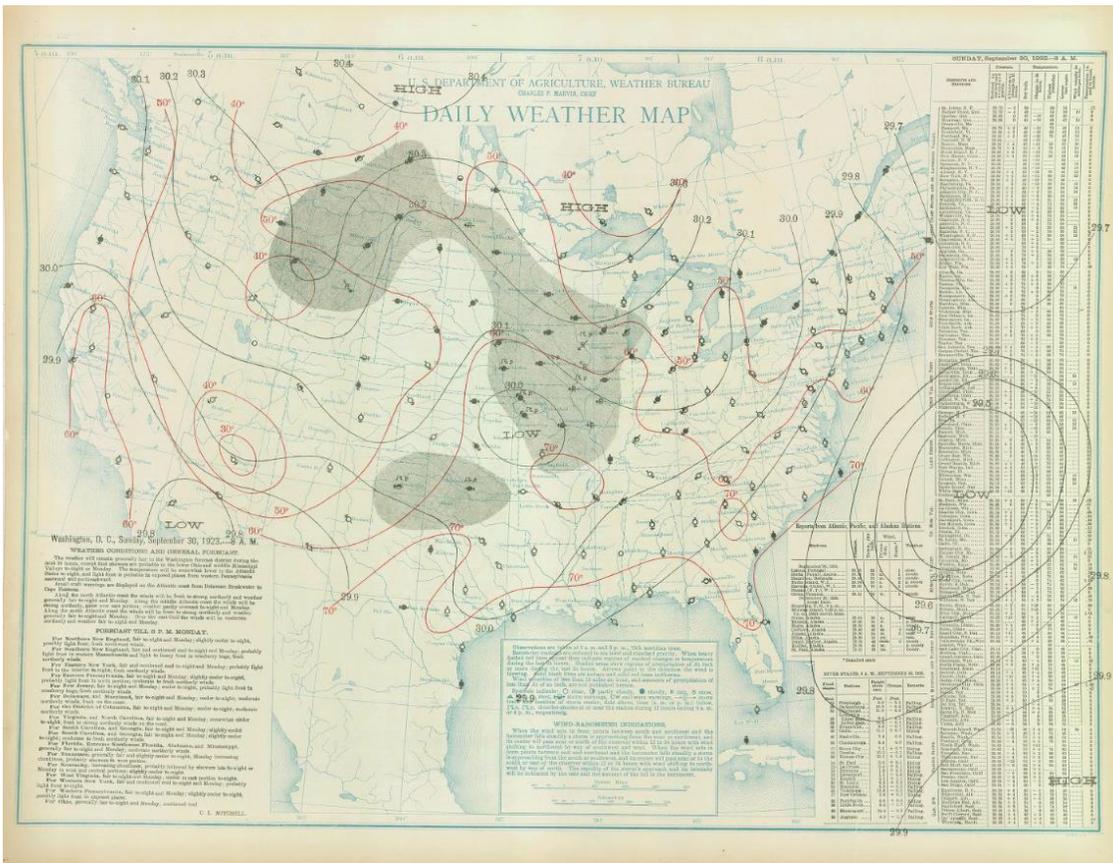
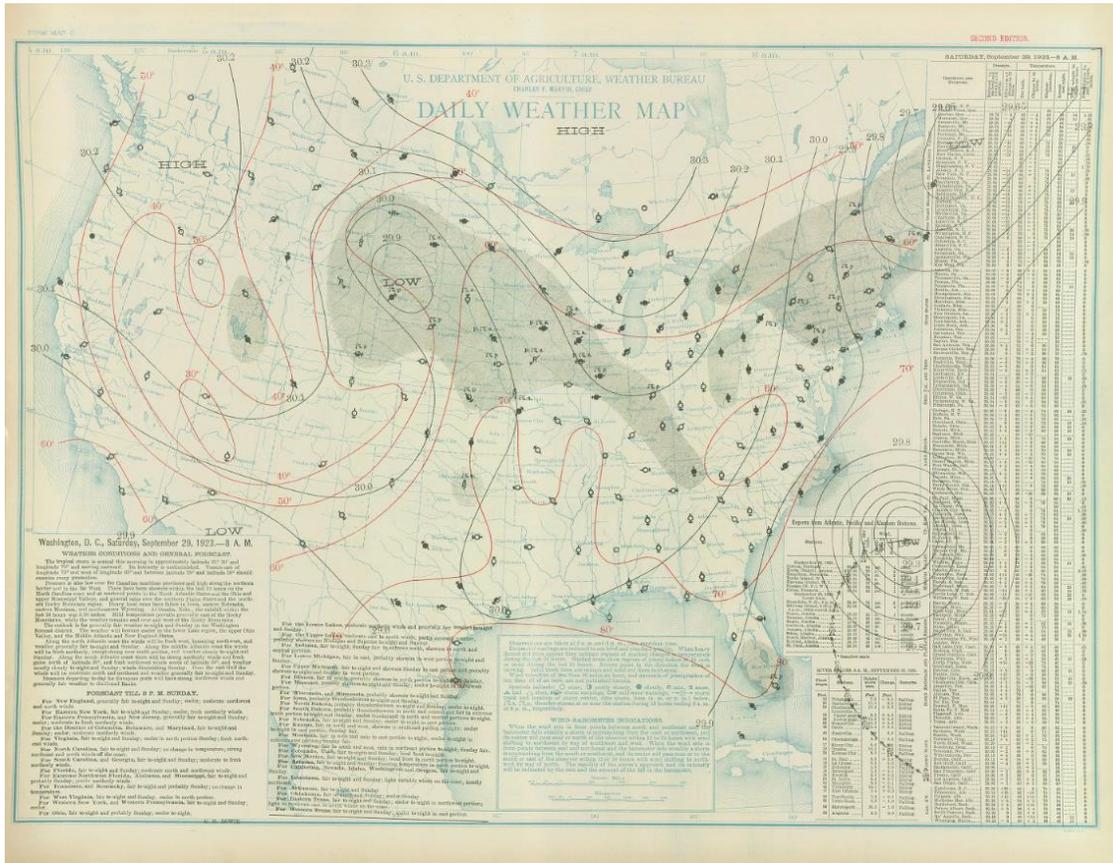


Total 144-hr Precipitation (inches)
September 26, 1923 0800 UTC - October 2, 1923 0800 UTC
SPAS #1325

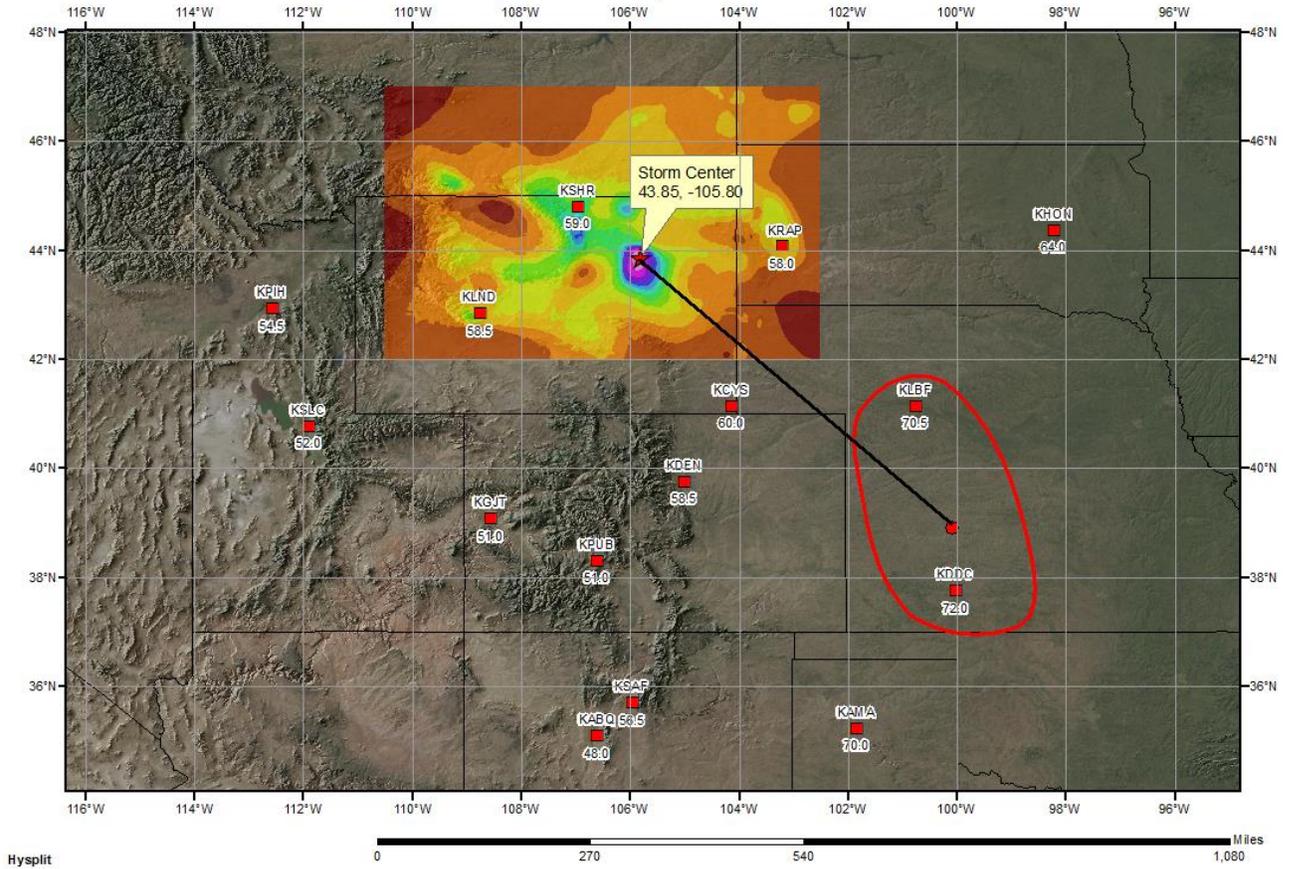
Precipitation (inches)		Stations
0.19 - 1.00	7.01 - 8.00	◆ Daily
1.01 - 2.00	8.01 - 9.00	■ Hourly
2.01 - 3.00	9.01 - 10.00	□ Hourly Estimated
3.01 - 4.00	10.01 - 12.00	■ Hourly Estimated Pseudo
4.01 - 5.00	12.01 - 14.00	◆ Supplemental
5.01 - 6.00	14.01 - 16.00	
6.01 - 7.00	16.01 - 18.00	







SPAS 1325 Savageton, WY Storm Analysis September 26-29, 1923



Storm Precipitation Analysis System (SPAS) For Storm #1433_1 SPAS Analysis

General Storm Location: Collinsville, Illinois (40.0, -91.5, 36.9, -87.3)

Storm Dates: August 13 – August 16, 1946

Event: Extreme Precipitation Event

DAD Zone 1

Latitude: 38.6708

Longitude: -90.0042

Max. Grid rainfall amount: 19.07"

Max. Observed rainfall amount: 19.07" (Collinsville, IL)

Number of Stations: 166

SPAS Version: 10.0

Base Map Used: Derived basemap based off of SPAS analysis

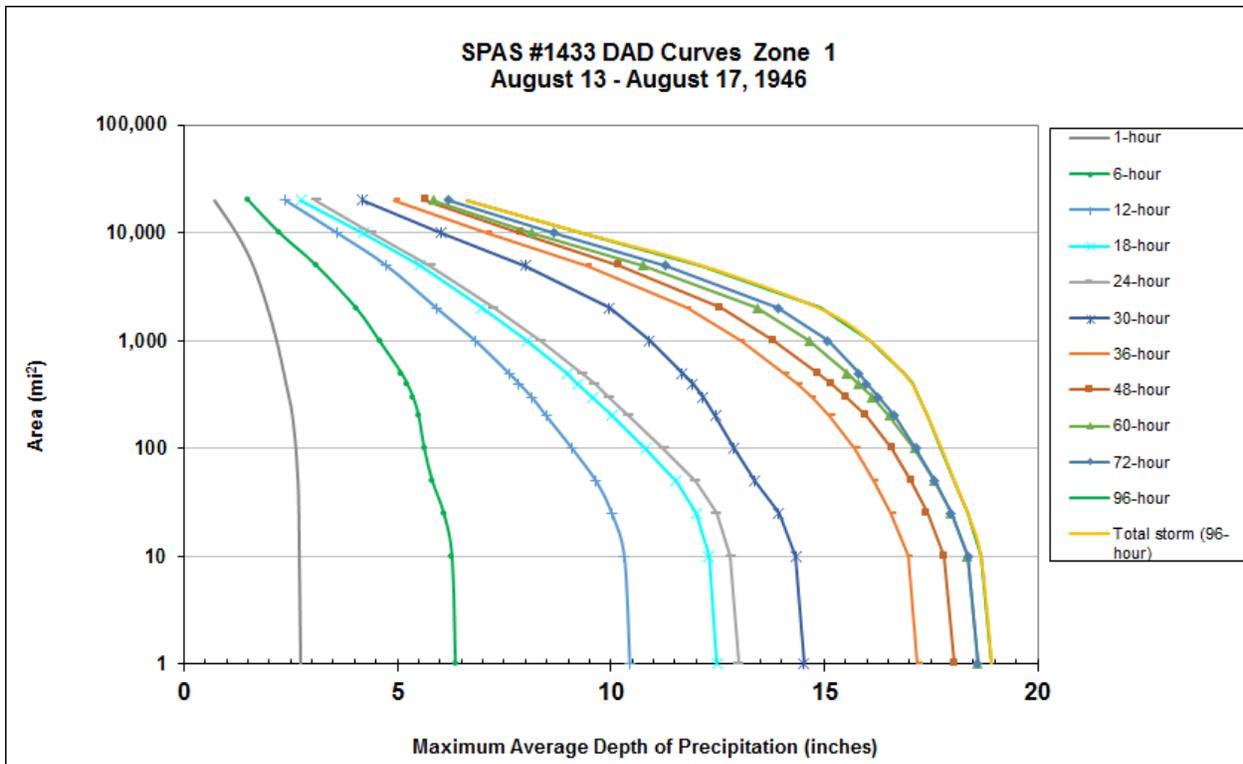
Spatial resolution: 0.2596

Radar Included: No

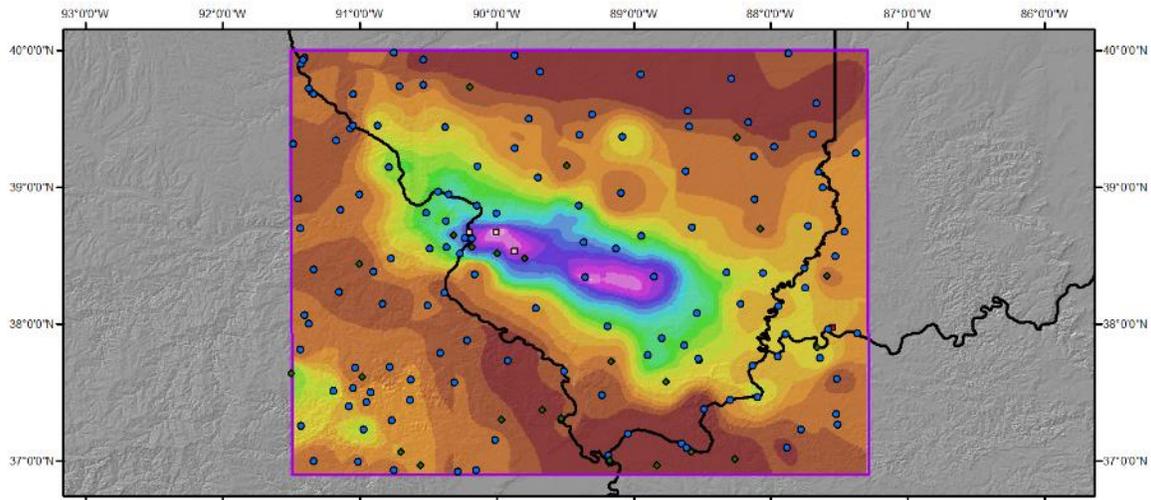
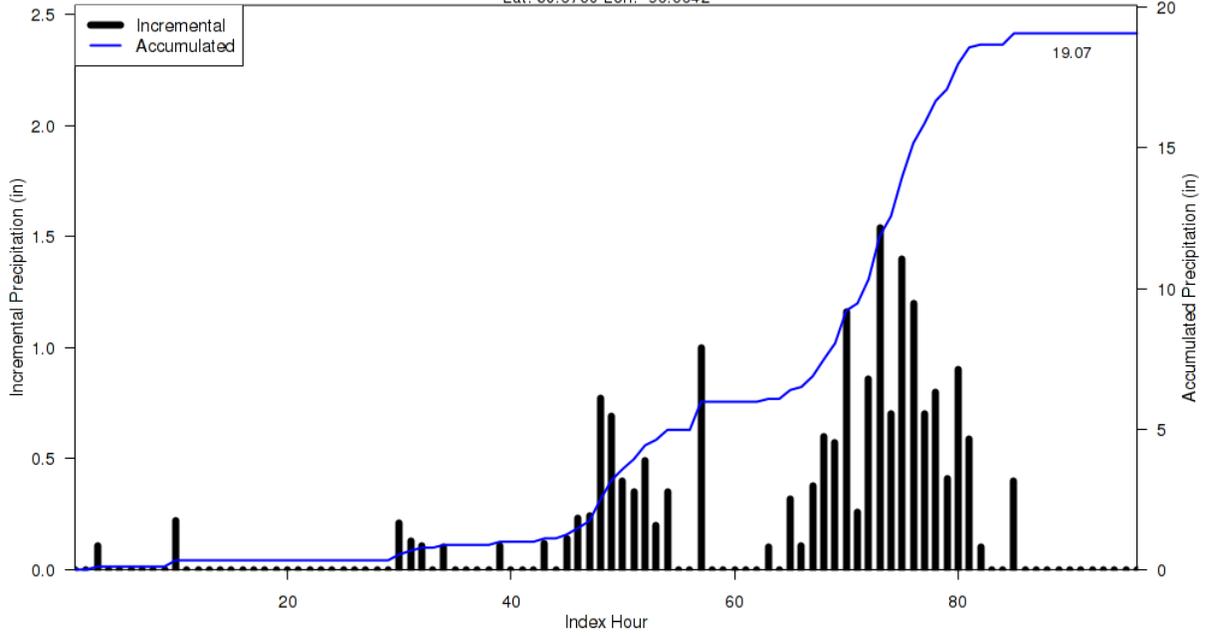
Depth-Area-Duration (DAD) analysis: Yes

Reliability of Results: In addition to the NCDC stations, twenty-four supplemental stations were added to ensure data consistency. Due to the amount and integrity of the U.S. Army Corps of Engineers (USACE), three hourly stations were added based on the mass rainfall curves. Three hourly stations were also added from local climatology from NCDC. With the density of stations available and the consistency of the resulting SPAS analysis to the U.S. Army Corps of Engineers report, this analysis is deemed quite reliable.

Storm 1433 - August 13 (0700 UTC) - August 17 (0600 UTC), 1946												
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)												
Area (mi ²)	Duration (hours)											
	1	6	12	18	24	30	36	48	60	72	96	Total
0.4	2.72	6.39	10.49	12.56	13.07	14.60	17.28	18.15	18.69	18.70	19.02	19.02
1	2.72	6.36	10.44	12.49	12.99	14.53	17.18	18.05	18.60	18.60	18.92	18.92
10	2.69	6.28	10.31	12.30	12.81	14.33	16.96	17.82	18.36	18.37	18.67	18.67
25	2.68	6.09	10.02	12.00	12.47	13.94	16.56	17.42	17.97	17.97	18.36	18.36
50	2.66	5.82	9.65	11.54	11.99	13.38	16.16	17.04	17.58	17.59	18.05	18.05
100	2.61	5.63	9.09	10.81	11.23	12.89	15.72	16.59	17.12	17.16	17.75	17.75
200	2.53	5.50	8.49	10.04	10.42	12.46	15.14	15.98	16.53	16.64	17.42	17.42
300	2.45	5.37	8.14	9.56	9.95	12.16	14.70	15.52	16.13	16.26	17.21	17.21
400	2.38	5.23	7.85	9.22	9.61	11.91	14.36	15.16	15.80	15.99	17.06	17.06
500	2.33	5.10	7.61	8.97	9.33	11.67	14.05	14.86	15.54	15.81	16.86	16.86
1,000	2.16	4.58	6.82	8.03	8.34	10.91	13.02	13.82	14.65	15.08	16.08	16.08
2,000	1.95	4.04	5.92	6.97	7.25	9.96	11.78	12.57	13.42	13.91	14.90	14.90
5,000	1.61	3.10	4.73	5.55	5.77	8.00	9.44	10.21	10.76	11.28	12.14	12.14
10,000	1.22	2.24	3.58	4.21	4.39	6.04	7.12	7.90	8.15	8.68	9.35	9.35
20,000	0.71	1.51	2.37	2.75	3.09	4.18	4.94	5.66	5.84	6.21	6.64	6.64



SPAS 1433 Storm Center Mass Curve Zone 1
August 13 (0700UTC) to August 17 (0600UTC), 1946
 Lat: 38.6708 Lon: -90.0042



Total 96-hour Precipitation (Inches)
August 13, 1946 0700 UTC - August 16, 1946 0600 UTC
SPAS #1433

Precipitation (Inches)		Stations	
0.10 - 1.00	4.01 - 5.00	9.01 - 10.00	14.01 - 15.00
1.01 - 2.00	5.01 - 6.00	10.01 - 11.00	15.01 - 16.00
2.01 - 3.00	6.01 - 7.00	11.01 - 12.00	16.01 - 17.00
3.01 - 4.00	7.01 - 8.00	12.01 - 13.00	17.01 - 18.00
	8.01 - 9.00	13.01 - 14.00	18.01 - 19.00
		19.01 - 20.00	
			● Daily
			■ Hourly
			□ Hourly Estimated
			◆ Supplemental



WJM 10/27/2014

STORM STUDIES - PERTINENT DATA SHEET



Storm of 12-16 August 1946
 Assignment MR 7-2B
 Location Mo., Ill., Ind. & Ky.
 Study Prepared by:
 Upper Mississippi Valley
 Division
 St. Louis District

Part I Reviewed by H. M. Sec. of
 Weather Bureau, 3/8/49
 Part II Approved by Office, Chief
 of Engineers for Distribution
 of Factual Data, 3/20/50
 Remarks: Center near
 Collinsville, Ill.
 Dewpt. 74° Ref. Pt. 225 S
 Grid F-12

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000
 Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data).....	58
Form 5001-B (24-hour " " " ").....	—
Form 5001-D (" " " " " ").....	16
Misc. precip. records, meteorological data, etc.....	15
Form 5002 (Mass rainfall curves).....	44

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000
 Data and computation sheets:

Form S-10 (Data from mass rainfall curves).....	5
Form S-11 (Depth-area data from isohyetal map).....	3
Form S-12 (Maximum depth-duration data).....	7
Maximum duration-depth-area curves.....	1
Data relating to periods of maximum rainfall.....	2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	114
Max. Sta.	6.4	10.2	12.6	12.7	14.1	18.0	18.1	18.6	18.7	19.4	19.5
10	6.0	9.8	12.1	12.1	13.7	17.5	17.6	18.3	18.3	18.9	19.0
100	5.6	8.8	10.9	11.1	13.2	16.6	16.7	17.5	17.6	18.0	18.1
200	5.4	8.3	10.5	10.6	13.0	16.2	16.3	17.2	17.3	17.7	17.8
500	5.2	7.7	9.7	9.9	12.8	15.5	15.6	16.7	16.9	17.1	17.2
1,000	4.9	7.0	8.9	9.0	12.6	14.7	14.8	15.9	16.0	16.3	16.4
2,000	4.3	6.1	7.6	7.8	11.2	13.3	13.4	14.3	14.3	14.6	14.7
5,000	3.3	4.8	5.9	6.0	8.6	10.4	10.6	11.3	11.4	11.6	11.8
10,000	2.4	3.7	4.5	4.6	6.6	8.0	8.2	8.7	8.8	9.0	9.1
20,000	1.5	2.5	3.1	3.2	4.5	5.6	5.8	6.0	6.1	6.3	6.5
20,400	1.5	2.5	3.1	3.2	4.5	5.5	5.7	6.0	6.1	6.3	6.4

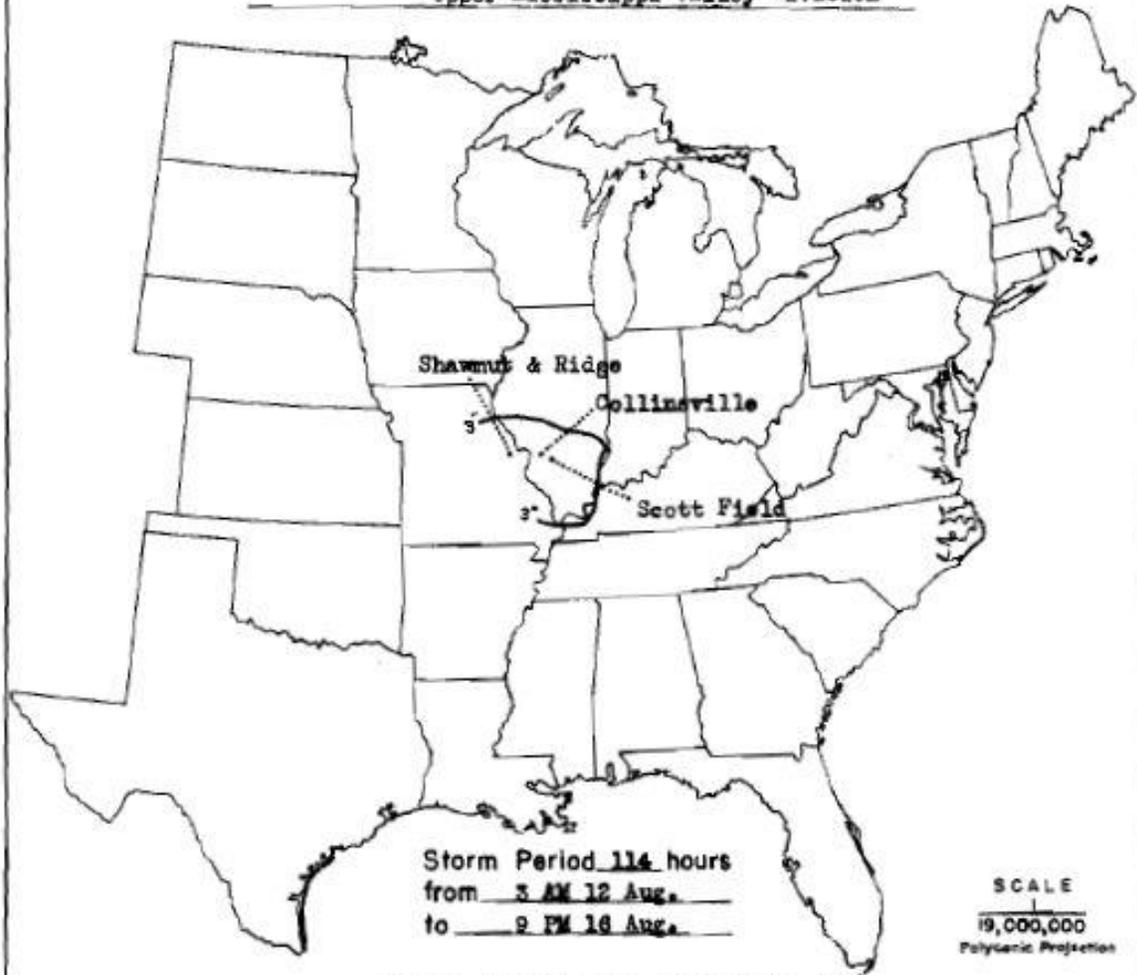
DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

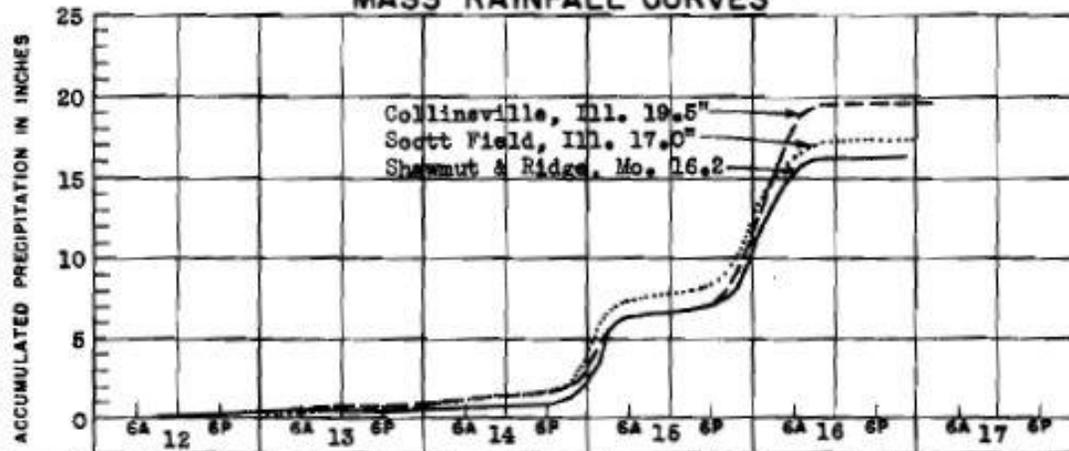
STORM STUDIES - ISOHYETAL MAP

Storm of 12-16 August 1946 Assignment MR 7-2B

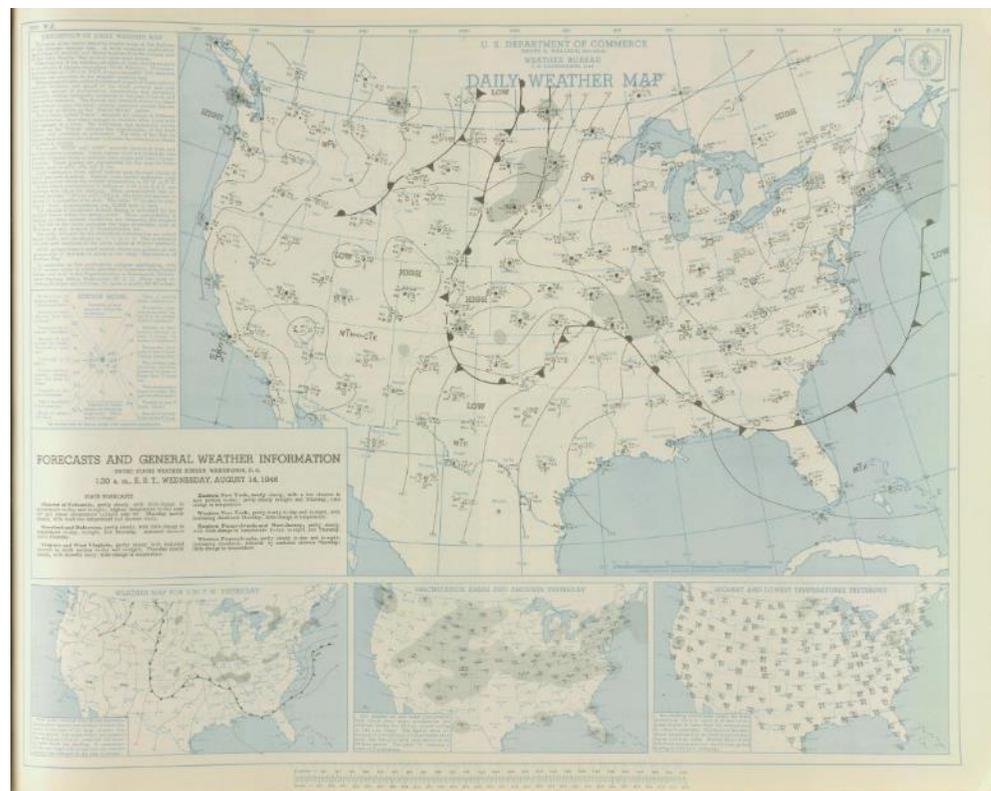
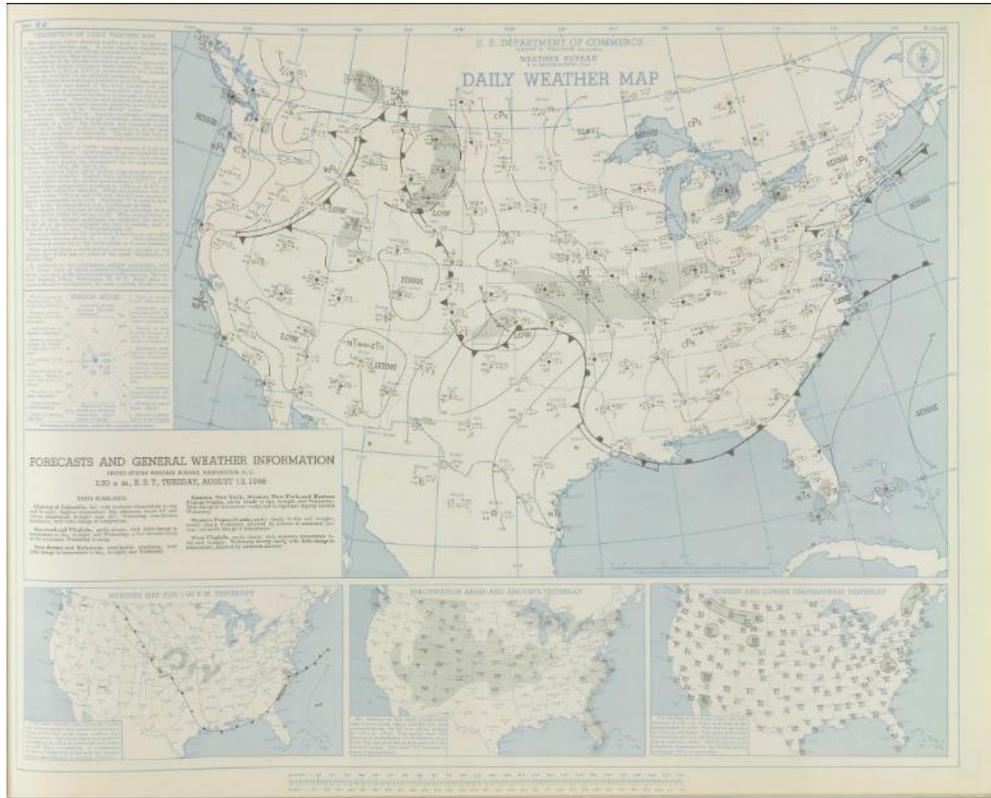
Study Prepared by: St. Louis, Mo. District
Upper Mississippi Valley Division

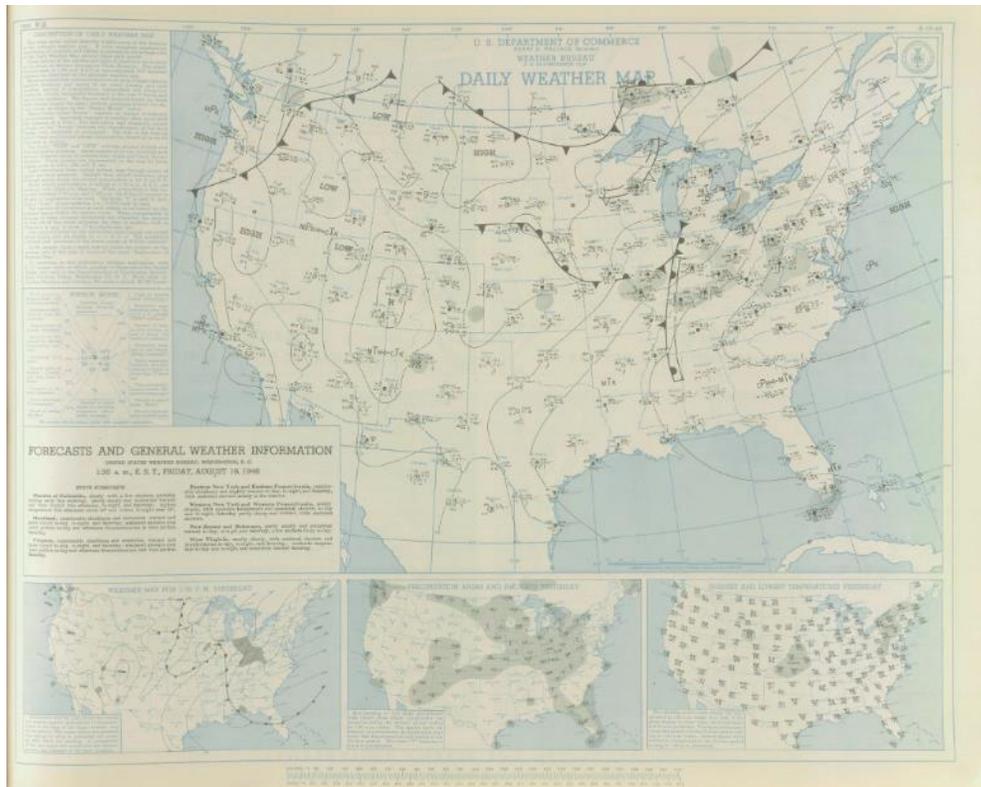
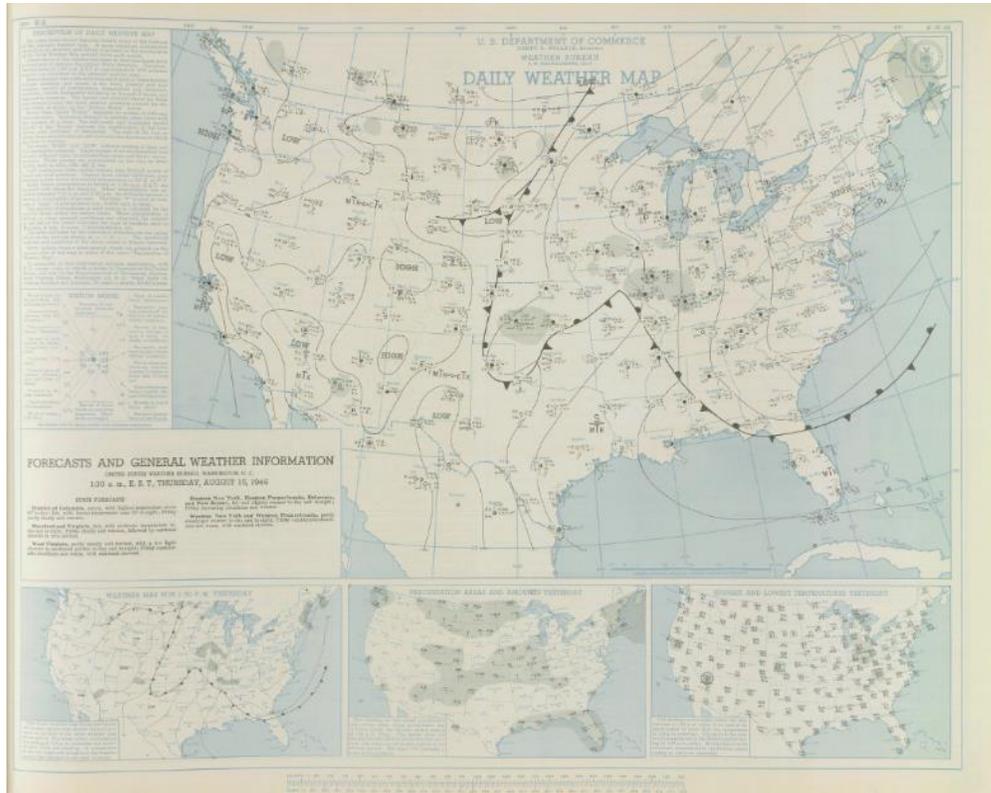


MASS RAINFALL CURVES

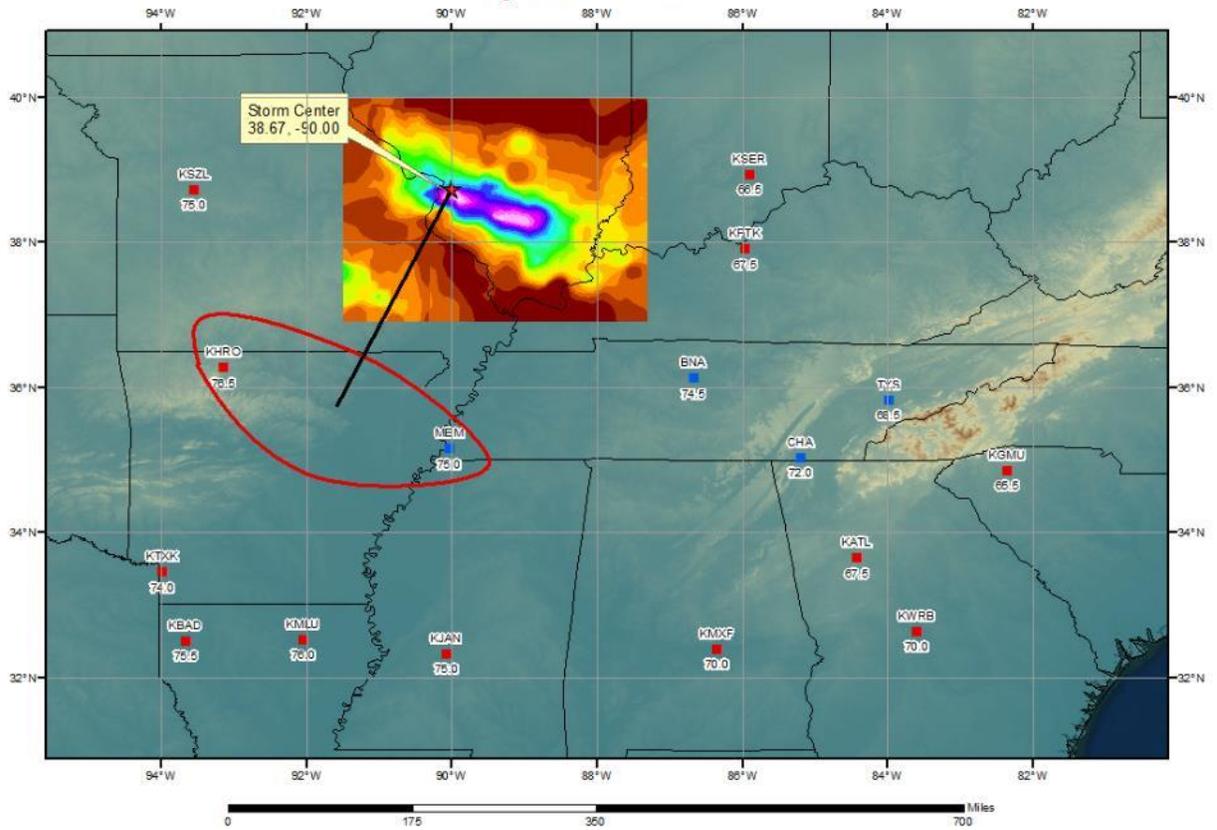


FORM 5-36

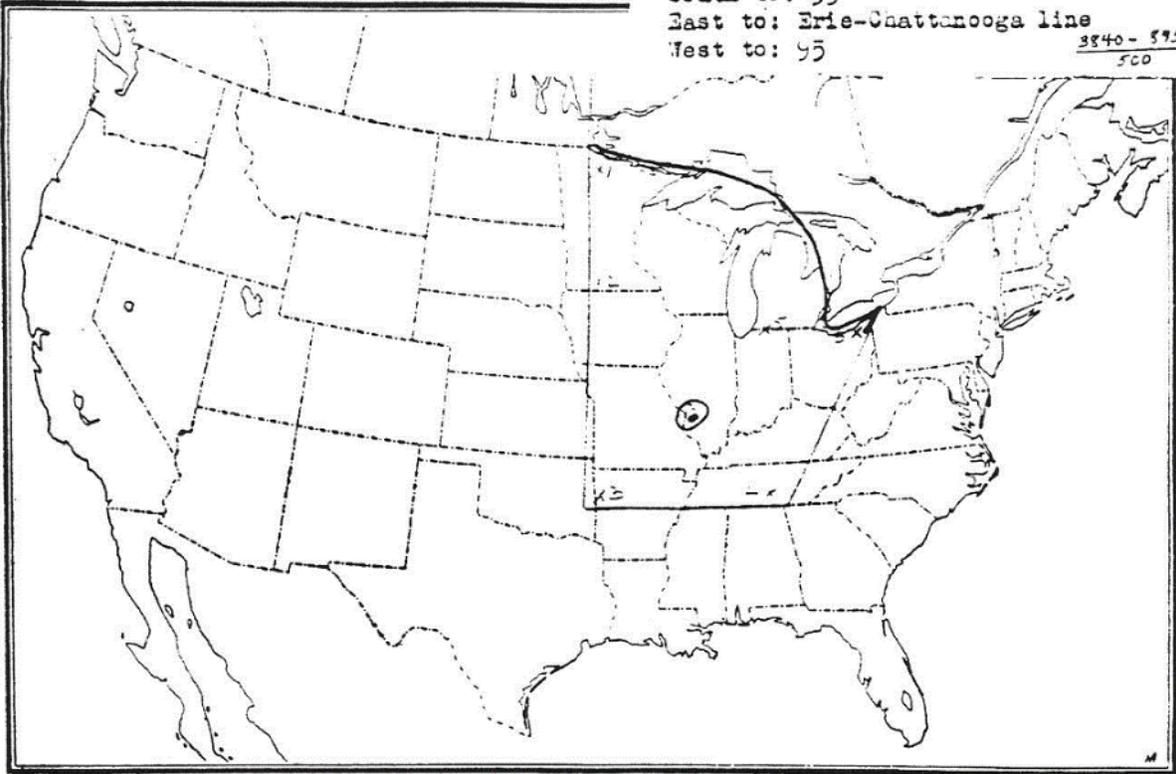




SPAS 1433 Collinsville, IL Storm Analysis August 14-15, 1946



MR 7-2B..Aug. 12-16, 1946..Collinsville
12-hr. rTd 74..225 S..to 78, 21 1/2
North to border
South to: 35
East to: Erie-Chattanooga line
West to: 95



Storm Precipitation Analysis System (SPAS) For Storm #1583_1 SPAS Analysis

General Storm Location: Kansas, Oklahoma, Nebraska, Colorado, Iowa, Missouri, Arkansas

Storm Dates: July 9-13, 1951

Event: Hurricane Georges

DAD Zone 1

Latitude: 38.65

Longitude: -96.62

Max. Grid Rainfall Amount: 18.56"

Max. Observed Rainfall Amount: 18.50

Number of Stations: 985

SPAS Version: 10.0

Base Map Used: conus_prism_ppt_in_1971_2000_07

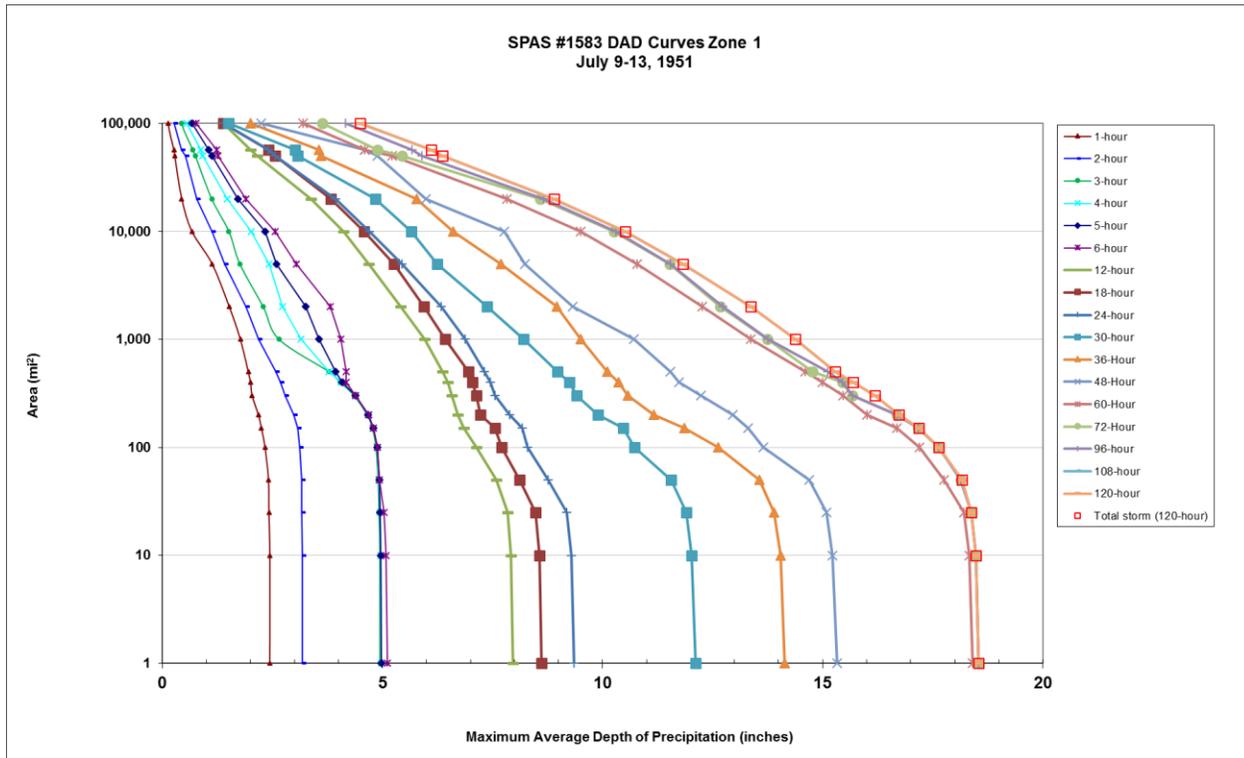
Spatial resolution: 00:00:30 (0.3 sq. miles)

Radar Included: No

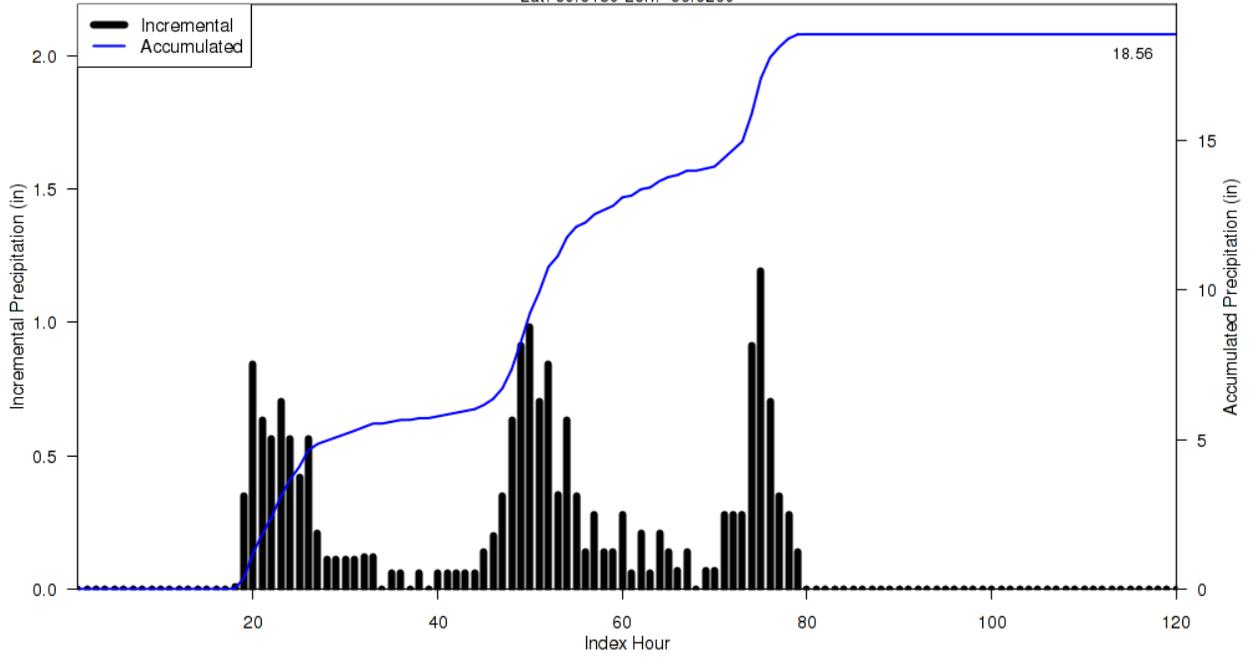
Depth-Area-Duration (DAD) analysis: Yes

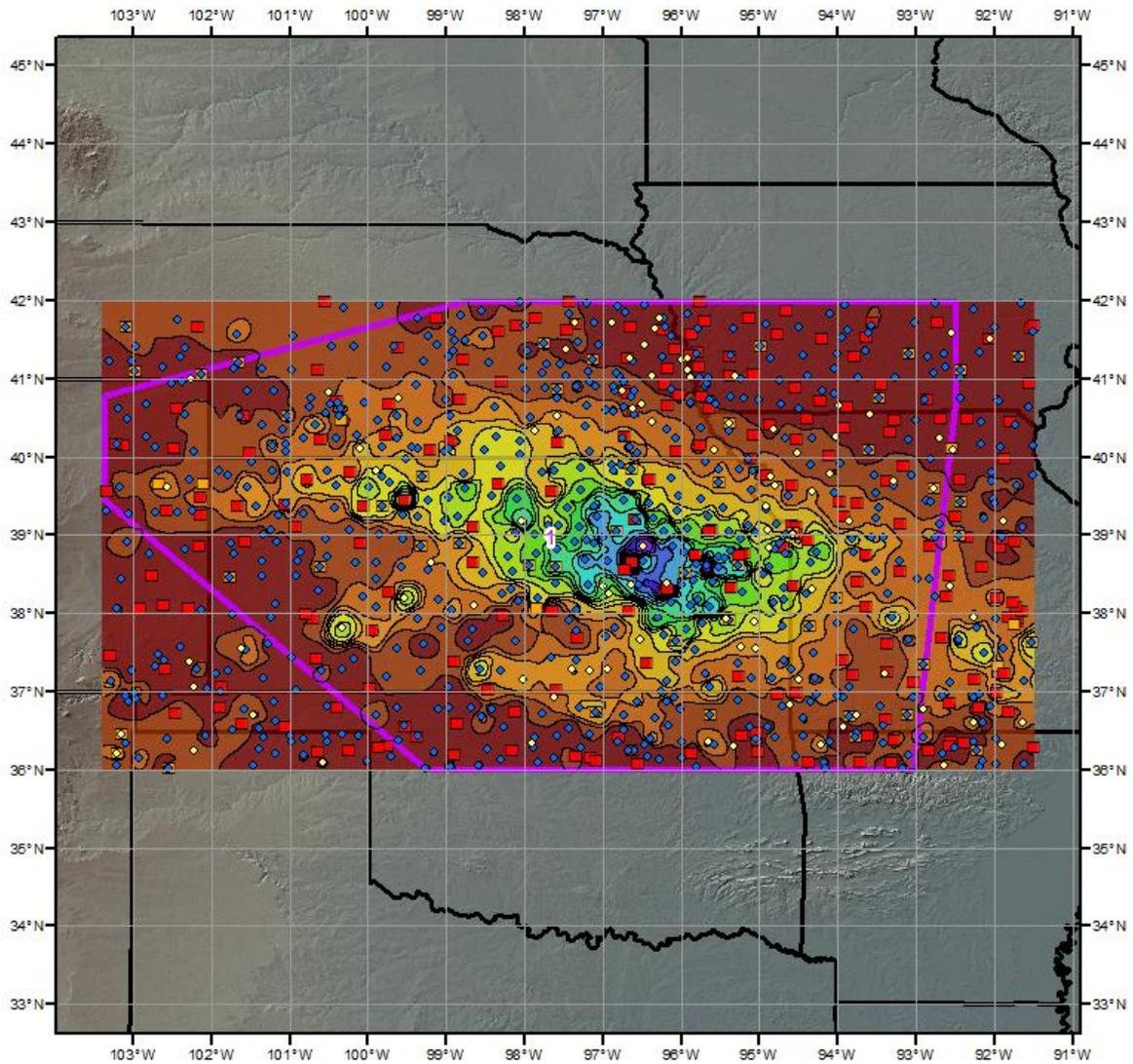
Reliability of results: This analysis was based on hourly data (H), hourly pseudo data (HP), daily data (D) and supplemental data (S). We have a high degree of confidence in the station based storm total results. The spatial pattern is dependent on basemap, and the timing is based on hourly and hourly pseudo stations.

Storm 1583 Zone 1 - Jul. 9 (0700 UTC) - Jul. 14 (0600 UTC), 1951																		
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)																		
areasqmi	Duration (hours)																	
	1-hr	2-hr	3-hr	4-hr	5-hr	6-hr	12-hr	18-hr	24-hr	30-hr	36-hr	48-hr	60-hr	72-hr	96-hr	108-hr	120-hr	Total
0.3	2.44	3.18	4.95	4.97	4.97	5.11	7.97	8.62	9.35	12.11	14.14	15.33	18.41	18.56	18.56	18.56	18.56	18.56
1	2.44	3.18	4.94	4.97	4.97	5.11	7.97	8.62	9.35	12.11	14.14	15.33	18.40	18.55	18.55	18.55	18.55	18.55
10	2.44	3.18	4.94	4.96	4.96	5.08	7.92	8.57	9.29	12.03	14.05	15.23	18.33	18.48	18.48	18.48	18.48	18.48
25	2.42	3.17	4.92	4.95	4.95	5.03	7.84	8.48	9.19	11.91	13.90	15.08	18.21	18.37	18.37	18.37	18.37	18.37
50	2.41	3.16	4.90	4.92	4.93	4.93	7.59	8.11	8.77	11.56	13.57	14.70	17.76	18.14	18.14	18.16	18.16	18.16
100	2.33	3.12	4.85	4.88	4.88	4.89	7.14	7.71	8.30	10.73	12.62	13.65	17.20	17.63	17.63	17.64	17.64	17.64
150	2.25	3.07	4.77	4.79	4.79	4.80	6.84	7.55	8.17	10.47	11.85	13.31	16.68	17.17	17.17	17.18	17.18	17.18
200	2.18	2.99	4.65	4.67	4.67	4.69	6.71	7.23	7.89	9.90	11.17	12.96	16.00	16.68	16.68	16.73	16.73	16.73
300	2.04	2.78	4.36	4.38	4.38	4.38	6.58	7.14	7.55	9.41	10.57	12.23	15.47	15.67	15.67	16.19	16.19	16.19
400	2.00	2.68	4.04	4.07	4.08	4.17	6.48	7.04	7.45	9.25	10.36	11.74	15.00	15.45	15.45	15.69	15.69	15.69
500	1.95	2.58	3.79	3.79	3.93	4.17	6.37	6.95	7.31	8.98	10.11	11.54	14.60	14.77	15.12	15.29	15.29	15.29
1,000	1.77	2.19	2.65	3.15	3.55	4.05	5.95	6.43	6.87	8.21	9.51	10.71	13.37	13.75	13.76	14.38	14.38	14.38
2,000	1.52	1.90	2.29	2.72	3.25	3.81	5.42	5.94	6.34	7.37	8.96	9.32	12.26	12.67	12.73	13.36	13.36	13.36
5,000	1.13	1.42	1.76	2.43	2.59	3.04	4.69	5.26	5.45	6.24	7.69	8.24	10.79	11.53	11.54	11.83	11.83	11.83
10,000	0.67	1.12	1.51	2.02	2.33	2.56	4.11	4.58	4.71	5.66	6.61	7.77	9.51	10.25	10.31	10.51	10.51	10.51
20,000	0.44	0.78	1.12	1.48	1.72	1.90	3.37	3.83	3.93	4.84	5.78	5.99	7.83	8.58	8.66	8.89	8.90	8.90
50,000	0.28	0.52	0.75	0.92	1.12	1.26	2.15	2.56	2.56	3.08	3.60	4.89	5.21	5.44	5.89	6.37	6.37	6.37
57,000	0.26	0.43	0.69	0.87	1.05	1.23	2.01	2.41	2.41	3.01	3.56	4.60	4.60	4.89	5.67	6.11	6.11	6.11
100,000	0.13	0.26	0.43	0.56	0.68	0.77	1.38	1.38	1.38	1.51	2.00	2.25	3.20	3.63	4.16	4.48	4.49	4.49
200,206	0.09	0.16	0.23	0.30	0.38	0.44	0.79	0.99	1.06	1.29	1.53	1.79	2.20	2.38	2.66	2.67	2.68	2.68



SPAS 1583 Storm Center Mass Curve Zone 1
July 9 (0700UTC) to July 14 (0600UTC), 1951
Lat: 38.6458 Lon: -96.6208





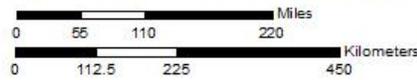
Total Storm (120-hours) Precipitation (inches)

July 9-13, 1951

SPAS 1583 Council Grove, KS (MR 10-2)

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental



Precipitation (inches)

■ 0.01 - 1.00	■ 5.01 - 6.00	■ 10.01 - 11.00	■ 15.01 - 16.00
■ 1.01 - 2.00	■ 6.01 - 7.00	■ 11.01 - 12.00	■ 16.01 - 17.00
■ 2.01 - 3.00	■ 7.01 - 8.00	■ 12.01 - 13.00	■ 17.01 - 18.00
■ 3.01 - 4.00	■ 8.01 - 9.00	■ 13.01 - 14.00	■ 18.01 - 19.00
■ 4.01 - 5.00	■ 9.01 - 10.00	■ 14.01 - 15.00	



3/9/2016

DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

STORM STUDIES - PERTINENT DATA SHEET



Storm of 9-13 July 1951
 Assignment MR 10-2
 Location Kans., Nebr. Mo.
 Study Prepared by:
 Missouri River Division
 Kansas City District Office

Part I Reviewed by H. M. Sec. of
 Weather Bureau, 10/29/51
 Part II Approved by Office, Chief
 of Engineers for Distribution
 of Factual Data, 12/10/52
 Remarks: Center near
 Council Grove, Kans.
 Dewpt. 73°F-Ref.Pt. 205 SSW
 Grid F-16

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 1 sheet, scale 1: 1,000,000
 Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data).....	78
Form 5001-B (24-hour " ").....	-
Form 5001-D (" " " ").....	2
Misc. precip. records, meteorological data, etc.....	151
Form 5002 (Mass rainfall curves).....	61

PART II

Final isohyetal maps, in 1 sheet, scale 1: 1,000,000
 Data and computation sheets:

Form S-10 (Data from mass rainfall curves).....	7
Form S-11 (Depth-area data from isohyetal map).....	2
Form S-12 (Maximum depth-duration data).....	11
Maximum duration-depth-area curves.....	1
Data relating to periods of maximum rainfall.....	6

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours										
	6	12	18	24	30	36	48	60	72	96	108
Max. Station	5.8	7.5	8.2	9.3	13.1	13.5	14.4	17.9	18.5	18.5	18.5
10	5.3	7.0	7.9	8.6	11.8	13.1	14.3	17.2	18.2	18.2	18.2
100	4.7	6.4	7.4	7.9	10.6	12.4	13.8	16.3	17.5	17.5	17.5
200	4.6	6.2	7.2	7.5	10.2	12.0	13.3	15.9	17.0	17.0	17.0
500	4.3	5.8	6.7	7.0	9.5	11.3	12.4	15.0	16.2	16.2	16.2
1,000	4.0	5.5	6.3	6.6	9.0	10.5	11.5	14.2	15.5	15.5	15.5
2,000	3.8	5.1	5.9	6.2	8.3	9.6	10.5	13.1	14.6	14.6	14.6
5,000	3.4	4.5	5.1	5.4	7.2	8.4	9.3	11.7	13.0	13.1	13.1
10,000	2.9	3.9	4.4	4.8	6.2	7.3	8.2	10.4	11.4	11.5	11.5
20,000	2.4	3.2	3.7	4.1	5.1	6.1	6.9	8.6	9.4	9.6	9.6
50,000	1.3	2.0	2.5	2.8	3.4	4.0	4.7	5.8	6.3	6.5	6.5
57,000	1.1	1.7	2.3	2.5	3.0	3.8	4.4	5.4	5.9	6.0	6.0

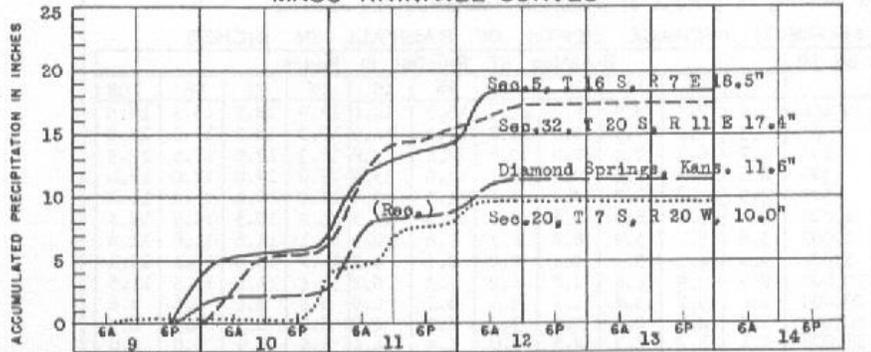
Form S-2

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS

STORM STUDIES - ISOHYETAL MAP
 Storm of 9-13 July 1951 Assignment MR 10-2
 Study Prepared by: Kansas City, Mo. District
Missouri River Division



MASS RAINFALL CURVES

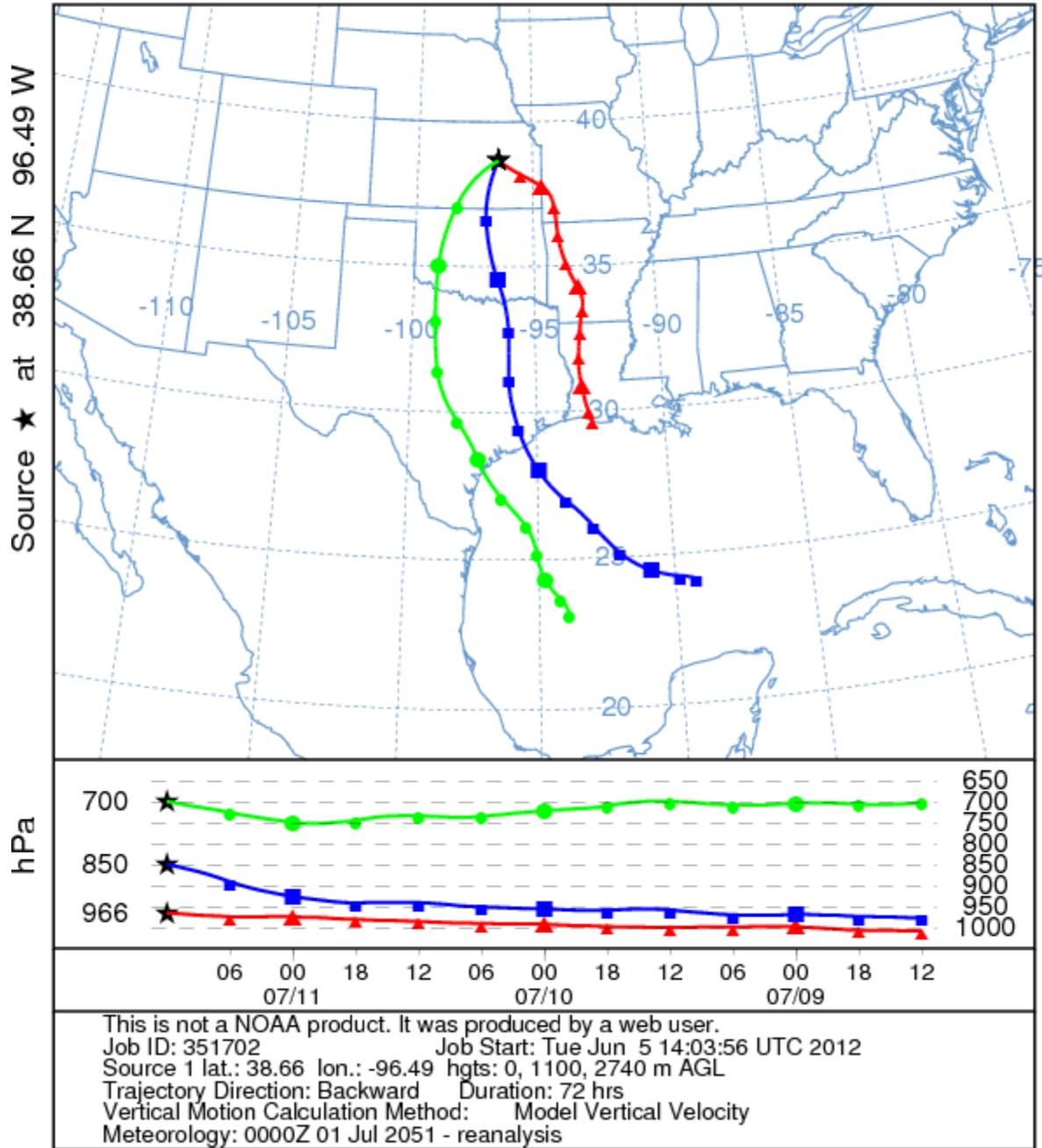


FORM 5-3E

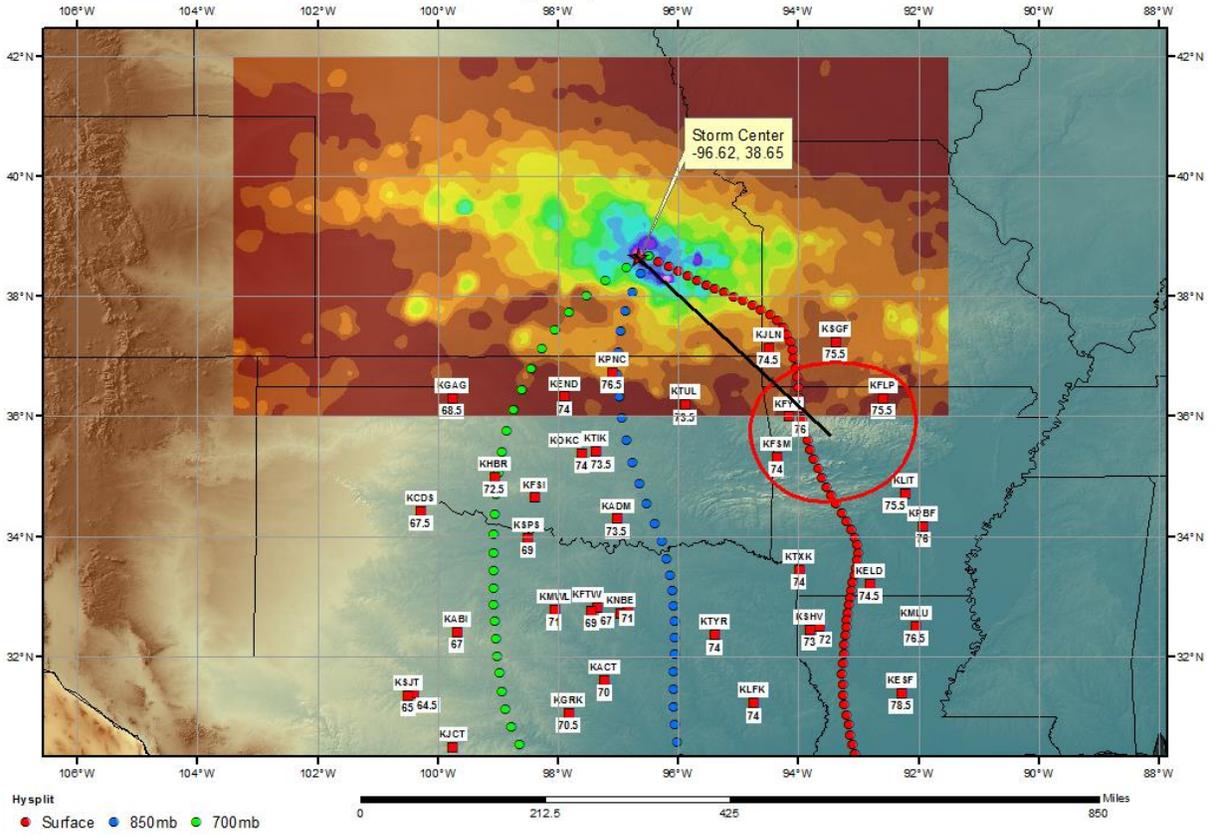
NOAA HYSPLIT MODEL

Backward trajectories ending at 1200 UTC 11 Jul 51

CDC1 Meteorological Data



SPAS 1583 Council Grove (MR 10-2) Storm Analysis July 9-11, 1951



Storm Precipitation Analysis System (SPAS) For Storm #1527_1 SPAS Analysis

General Storm Location: Ida Grove, IA

Storm Dates: August 28-31, 1962

Event: Synoptic

DAD Zone 1

Latitude: 42.3625

Longitude: -95.4958

Max. Grid/Radar Rainfall Amount: 12.67"

Max. Observed Rainfall Amount: 12.05"

Number of Stations: 462

SPAS Version: 10.0

Base Map Used: Blend_sm – EPRI storm 19 isoheytal pattern (20%) and us_ppt_1962_08_in_sum (80%)

Spatial resolution: 30 seconds

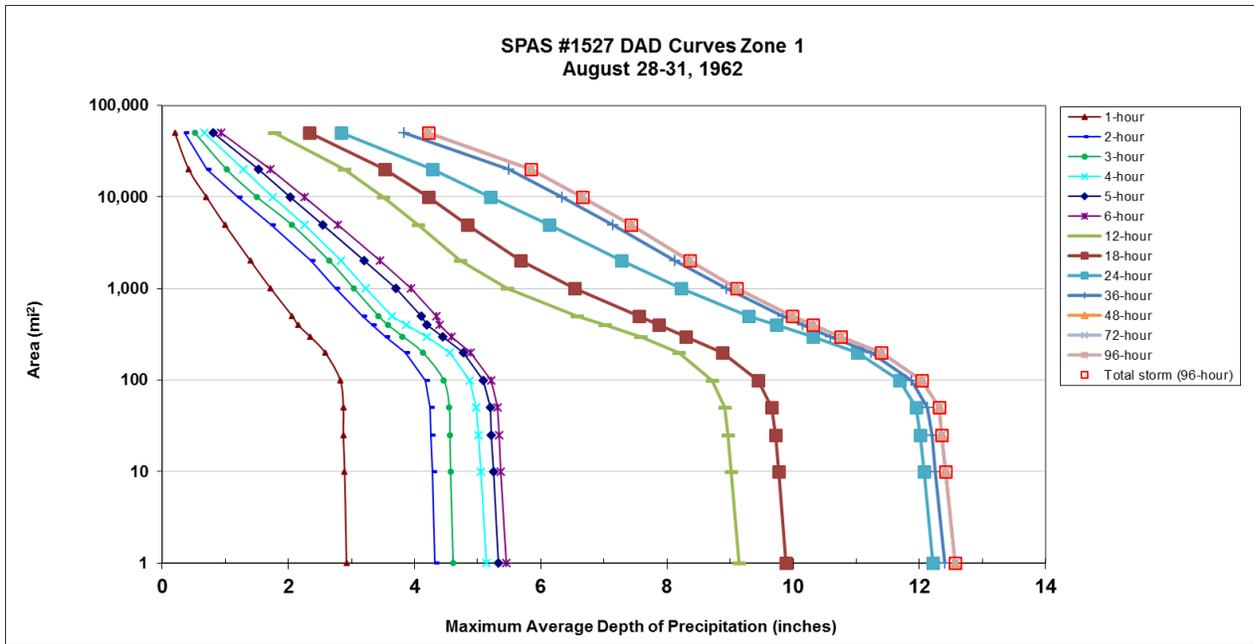
Radar Included: No

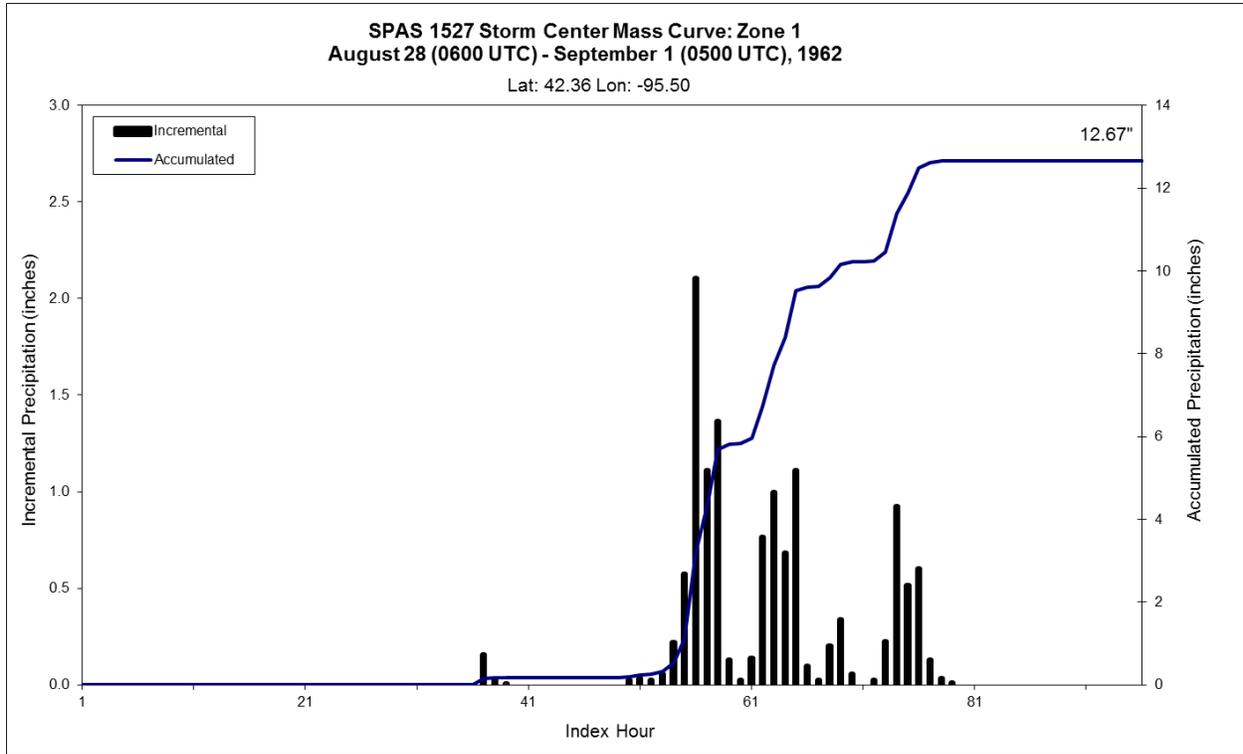
Depth-Area-Duration (DAD) analysis: Yes

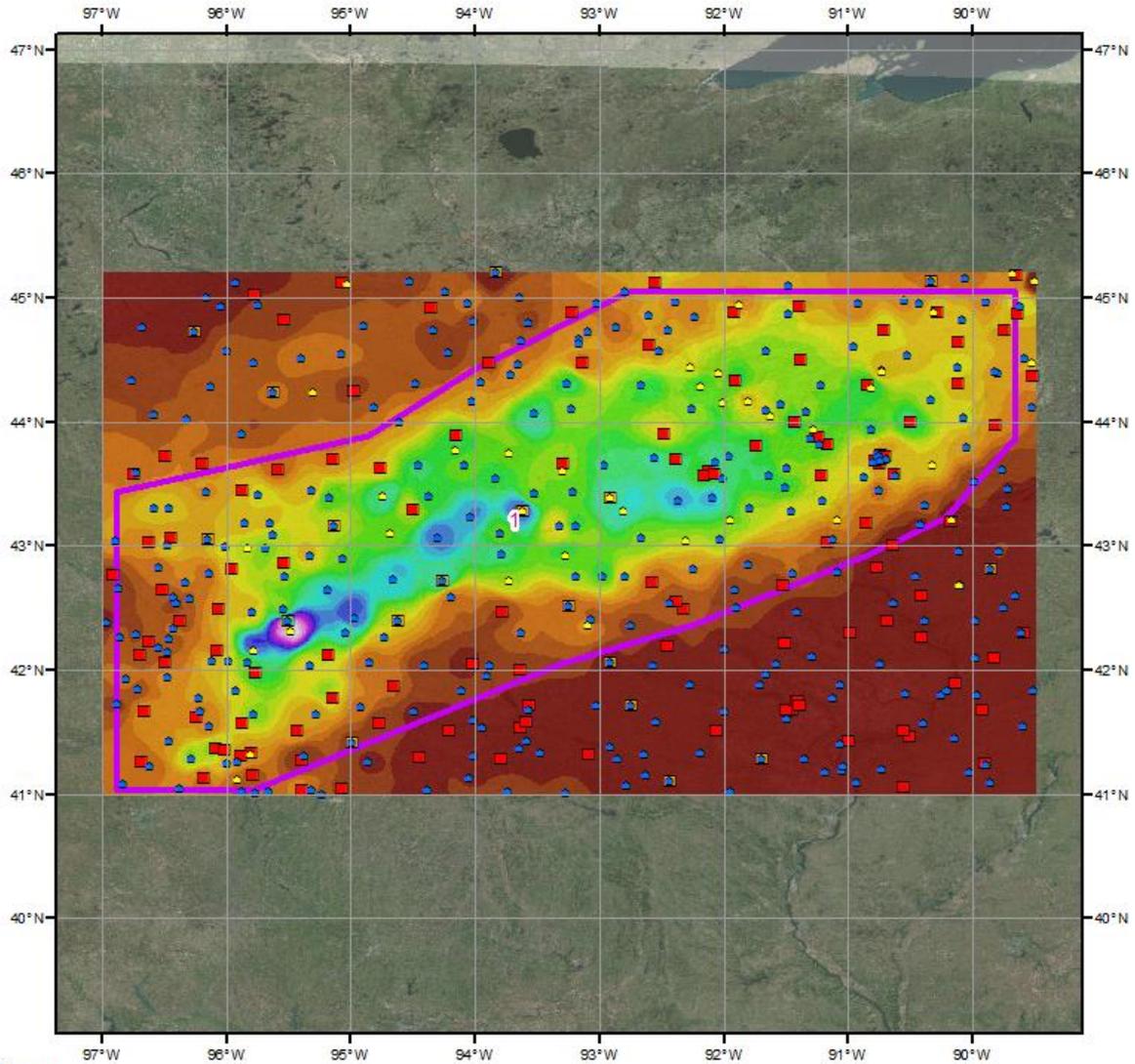
Reliability of Results:

This storm was originally analyzed as part of the Electric Power Research Institute (EPRI) Probable Maximum Precipitation Study (EPRI Storm 19). This analysis was based on an abundance of hourly data, daily data and supplemental station data. We have a good degree of confidence for the station based storm total results. The spatial pattern is dependent on the basemap, a blend between the EPRI storm isohyetal pattern and the PRISM August 1962 precipitation climatology (us_ppt_1962_08). There is a high degree of confidence with the timing based on the several hourly and hourly pseudo stations. Some daily stations were moved to supplemental due to timing issues. Additional details can be found in the "read_me_1527.txt" file. The Ida Grove 5 NW hourly station had missing data from August 30, 1900 CST to August 31, 0700 CST, so an estimated pseudo (HEP) station was created. The values not missing in the original station are comparable (although a little lower in magnitude) to the new HEP station.

Storm 1527 Zone 1 - Aug. 28 (0600 UTC) - Sep. 1 (0500 UTC), 1962														
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)														
areasqmi	Duration (hours)													
	1	2	3	4	5	6	12	18	24	36	48	72	96	Total
0.4	2.93	4.33	4.62	5.15	5.36	5.48	9.18	9.94	12.28	12.46	12.63	12.63	12.63	12.63
1	2.92	4.32	4.61	5.14	5.33	5.45	9.14	9.89	12.22	12.40	12.57	12.57	12.57	12.57
10	2.89	4.28	4.57	5.05	5.25	5.37	9.02	9.77	12.07	12.25	12.41	12.41	12.41	12.41
25	2.87	4.26	4.56	5.01	5.22	5.34	8.97	9.72	12.01	12.20	12.35	12.35	12.35	12.35
50	2.87	4.25	4.55	4.98	5.20	5.32	8.92	9.66	11.95	12.13	12.31	12.31	12.31	12.31
100	2.82	4.17	4.46	4.87	5.09	5.21	8.71	9.44	11.69	11.87	12.04	12.04	12.04	12.04
200	2.58	3.86	4.13	4.56	4.77	4.89	8.18	8.88	11.02	11.23	11.40	11.40	11.40	11.40
300	2.34	3.54	3.81	4.20	4.44	4.58	7.58	8.30	10.31	10.59	10.76	10.76	10.76	10.76
400	2.15	3.33	3.58	3.87	4.19	4.40	7.01	7.87	9.73	10.15	10.31	10.31	10.31	10.31
500	2.06	3.18	3.43	3.64	4.10	4.34	6.57	7.55	9.29	9.84	9.98	9.99	9.99	9.99
1,000	1.72	2.75	3.04	3.23	3.70	3.94	5.46	6.53	8.22	8.94	9.11	9.11	9.11	9.11
2,000	1.40	2.35	2.65	2.83	3.20	3.45	4.72	5.68	7.28	8.12	8.35	8.35	8.36	8.36
5,000	0.99	1.73	2.05	2.25	2.55	2.78	4.06	4.84	6.13	7.14	7.43	7.43	7.43	7.43
10,000	0.70	1.20	1.50	1.75	2.03	2.25	3.50	4.22	5.20	6.34	6.65	6.65	6.66	6.66
20,000	0.42	0.71	1.02	1.28	1.52	1.72	2.88	3.53	4.28	5.49	5.85	5.85	5.85	5.85
50,000	0.20	0.36	0.52	0.67	0.81	0.93	1.78	2.33	2.84	3.83	4.21	4.21	4.22	4.22







Gauges

- Daily
- Hourly
- Hourly Estimated Pseudo
- Hourly Pseudo
- Supplemental

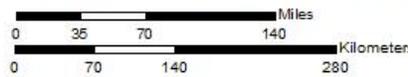
Total Storm (96-hours) Precipitation (inches)

August 28 - 31, 1962

SPAS 1527 - Ida Grove, IA

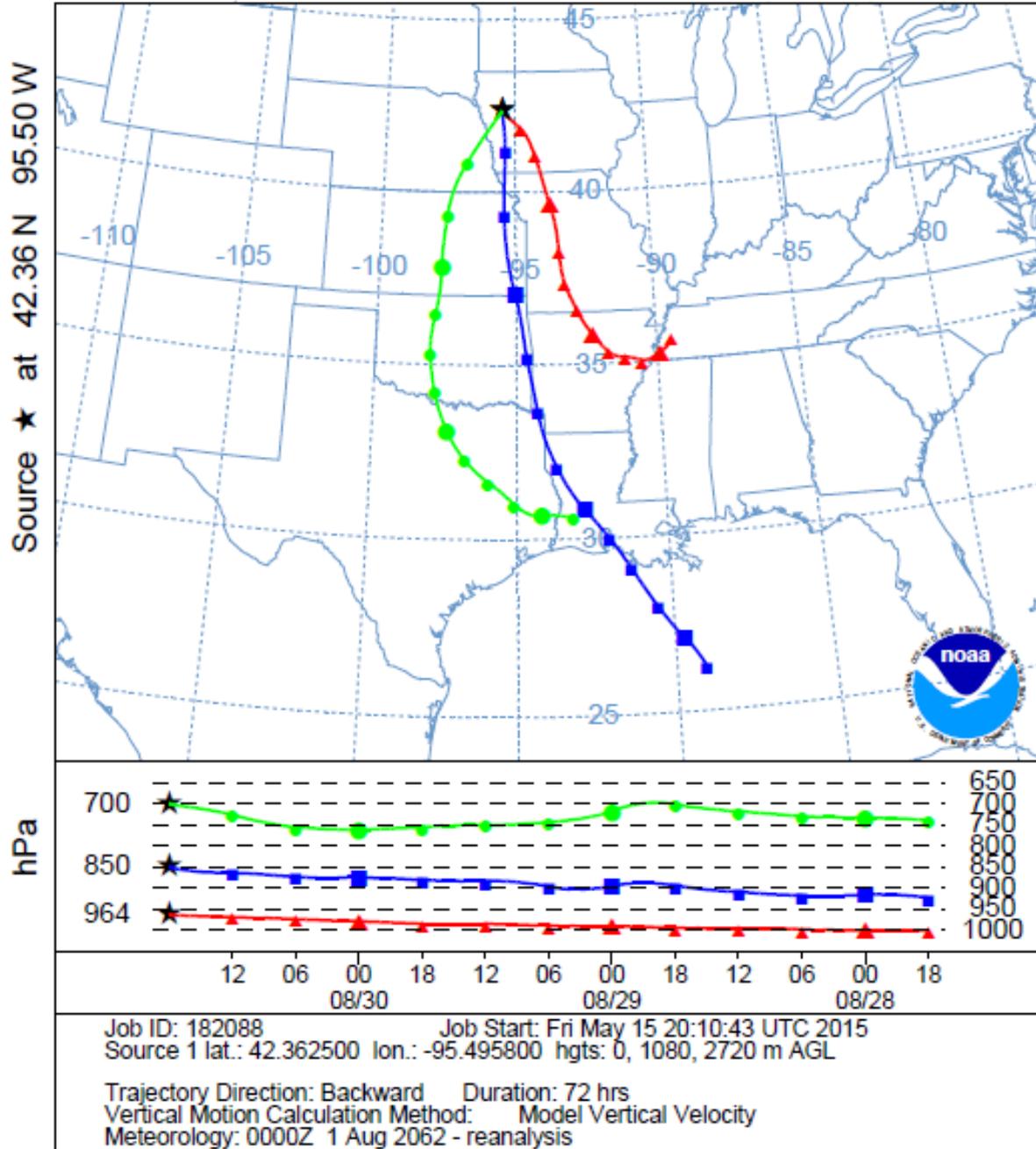
Precipitation (inches)

0.00 - 0.50	3.51 - 4.00	7.01 - 7.50	10.51 - 11.00
0.51 - 1.00	4.01 - 4.50	7.51 - 8.00	11.01 - 11.50
1.01 - 1.50	4.51 - 5.00	8.01 - 8.50	11.51 - 12.00
1.51 - 2.00	5.01 - 5.50	8.51 - 9.00	12.01 - 12.50
2.01 - 2.50	5.51 - 6.00	9.01 - 9.50	12.51 - 13.00
2.51 - 3.00	6.01 - 6.50	9.51 - 10.00	
3.01 - 3.50	6.51 - 7.00	10.01 - 10.50	

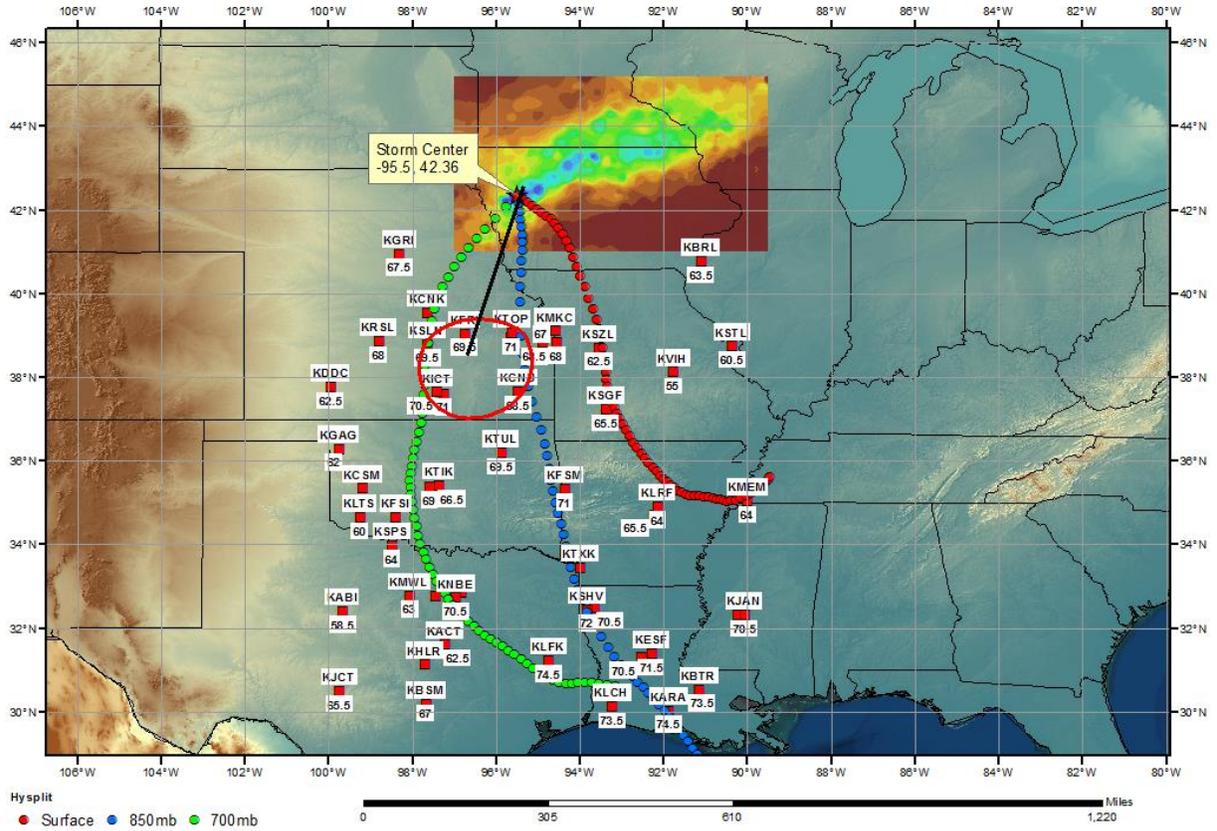


5/12/2015

NOAA HYSPLIT MODEL
 Backward trajectories ending at 1800 UTC 30 Aug 62
 CDC1 Meteorological Data



SPAS 1527 Ida Grove, IA Storm Analysis August 28 - 31, 1962



Storm Precipitation Analysis System (SPAS) For Storm #1630_1 SPAS Analysis

General Storm Location: Toronto, Ontario

Storm Dates: October 13-17, 1954

Event: Hurricane Hazel

DAD Zone 1

Latitude: 43.8375

Longitude: -79.9792

Max. Grid Rainfall Amount: 11.23"

Max. Observed Rainfall Amount: 11.23"

Number of Stations: 162

SPAS Version: 10.0

Basemap: Canadian Storm Study (ONT 10-54) Isohyetal Pattern

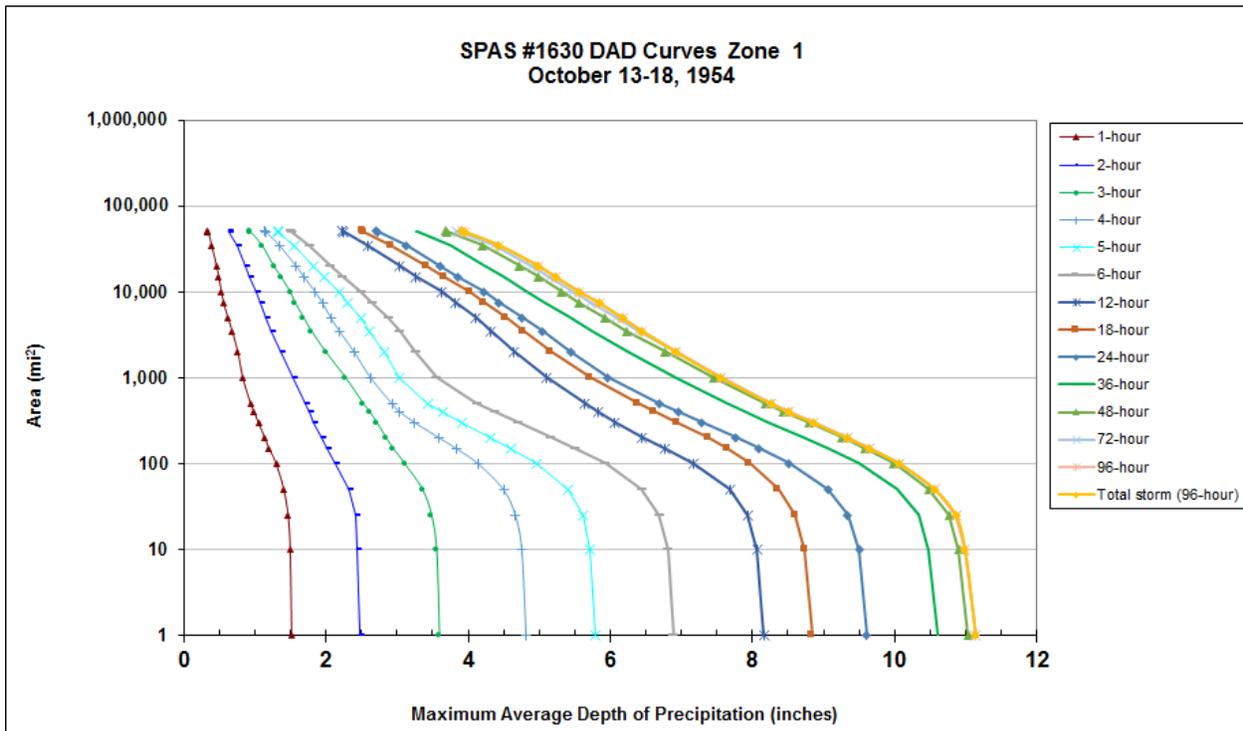
Spatial resolution: 0.3

Radar Included: No

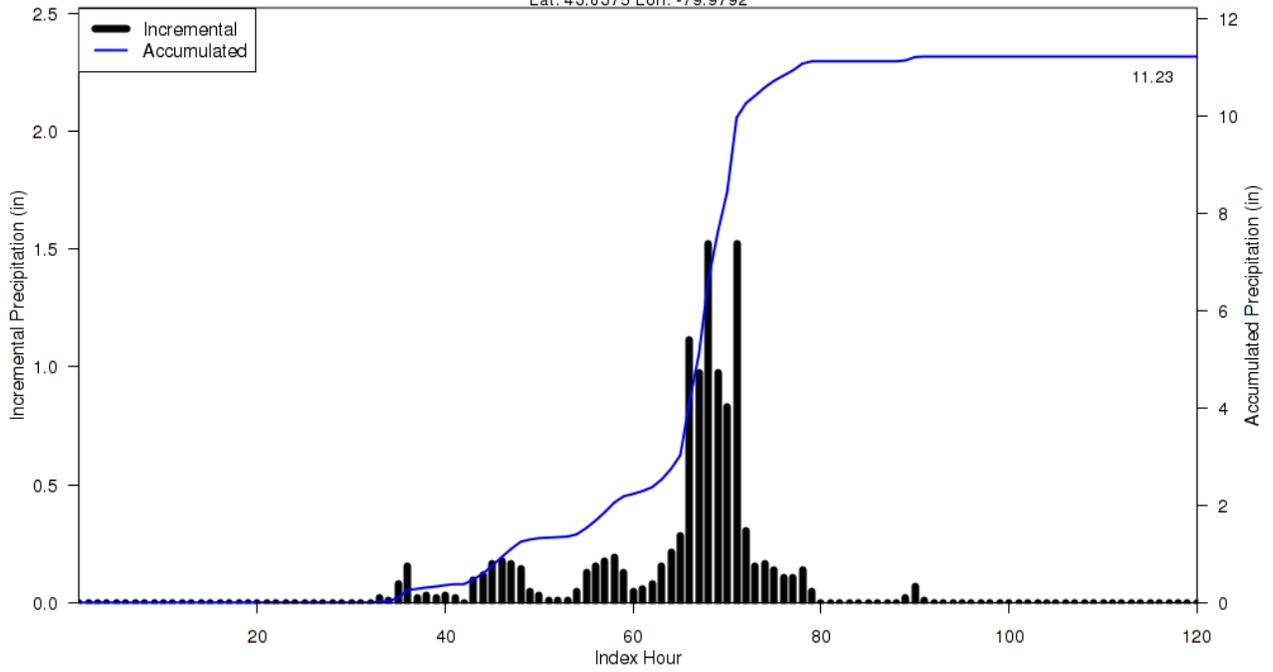
Depth-Area-Duration (DAD) analysis: Yes

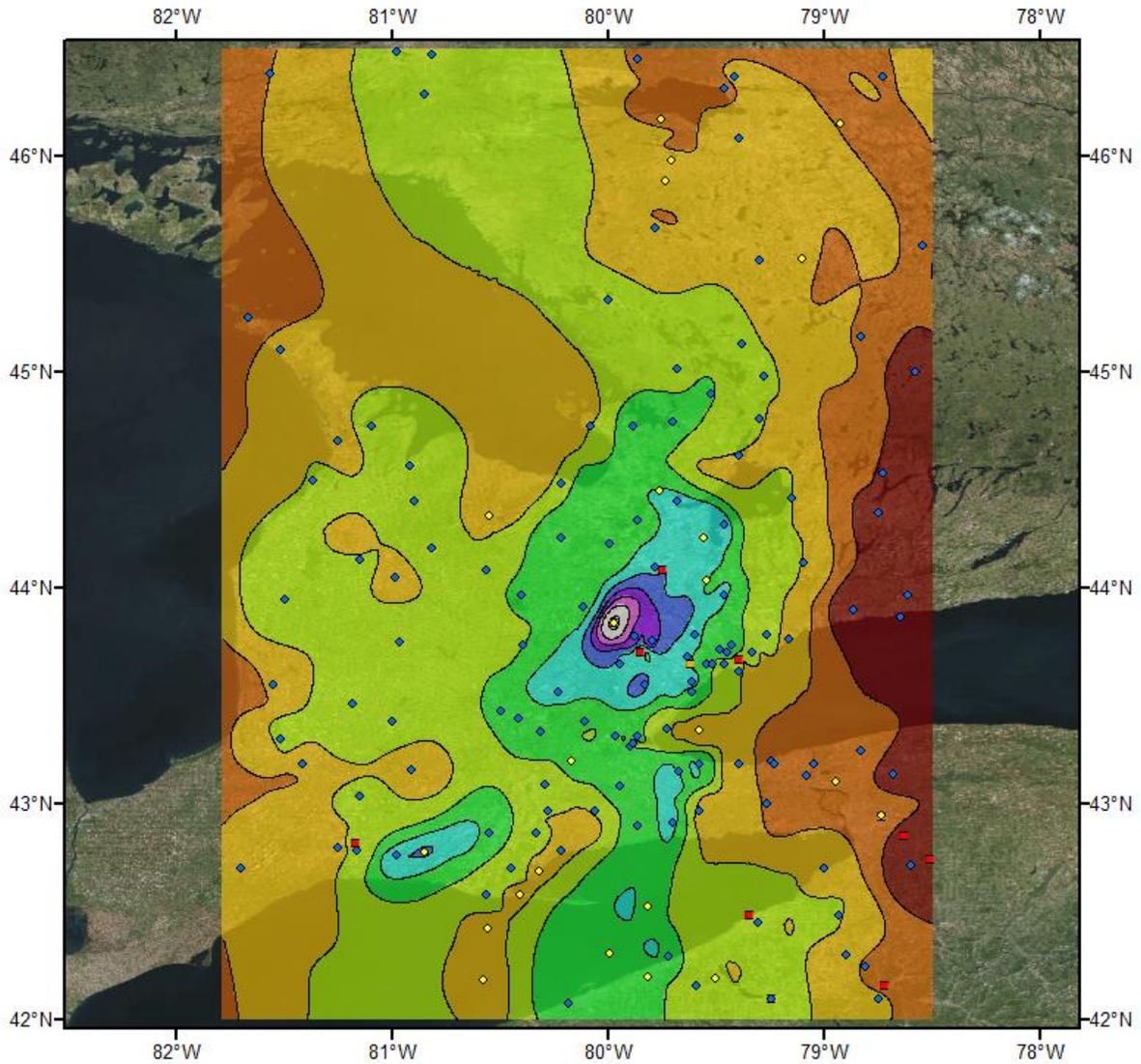
Reliability of results: This analysis was based on 162 hourly stations, daily stations, supplemental station data, the Canadian Storm Study Report ONT 10-54, and article from Anderson and Bruce 1957. We have a good degree of confidence for the station based storm total results. The spatial pattern is dependent heavily on the basemap. Timing is based on the hourly stations at the storm center. One daily station was moved to a supplemental station due to timing issues and to ensure data consistency.

Storm 1630 - October 13 (0600 UTC) - October 18 (0500 UTC), 1954														
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)														
Area (mi ²)	Duration (hours)													
	1	2	3	4	5	6	12	18	24	36	48	72	96	Total
0.4	1.52	2.50	3.60	4.84	5.81	6.92	8.20	8.88	9.65	10.67	11.10	11.20	11.20	11.20
1	1.52	2.48	3.59	4.82	5.79	6.89	8.16	8.84	9.61	10.61	11.04	11.14	11.14	11.14
10	1.50	2.43	3.55	4.76	5.72	6.81	8.07	8.74	9.50	10.47	10.90	10.99	10.99	10.99
25	1.47	2.41	3.48	4.67	5.62	6.69	7.93	8.60	9.34	10.34	10.77	10.86	10.86	10.86
50	1.41	2.32	3.35	4.50	5.41	6.44	7.68	8.36	9.06	10.04	10.48	10.57	10.57	10.57
100	1.30	2.14	3.10	4.14	4.97	5.93	7.17	7.96	8.52	9.50	9.99	10.06	10.07	10.07
150	1.20	2.02	2.94	3.83	4.61	5.50	6.76	7.64	8.09	9.06	9.58	9.65	9.65	9.65
200	1.14	1.94	2.84	3.59	4.32	5.16	6.45	7.38	7.77	8.71	9.26	9.33	9.33	9.33
300	1.05	1.83	2.71	3.25	3.92	4.70	6.06	6.94	7.29	8.22	8.79	8.86	8.86	8.86
400	0.99	1.76	2.61	3.04	3.64	4.37	5.82	6.62	6.95	7.89	8.43	8.50	8.51	8.51
500	0.94	1.71	2.52	2.93	3.44	4.12	5.64	6.39	6.69	7.64	8.18	8.25	8.26	8.26
1,000	0.83	1.53	2.27	2.63	3.03	3.55	5.11	5.72	5.97	6.92	7.45	7.56	7.56	7.56
2,000	0.76	1.36	1.99	2.40	2.83	3.26	4.65	5.16	5.44	6.24	6.77	6.91	6.93	6.93
3,500	0.68	1.23	1.79	2.19	2.62	3.04	4.32	4.78	5.05	5.74	6.23	6.39	6.45	6.45
5,000	0.62	1.16	1.68	2.07	2.50	2.87	4.11	4.53	4.76	5.43	5.92	6.08	6.17	6.17
7,500	0.56	1.08	1.56	1.95	2.31	2.64	3.82	4.22	4.44	5.07	5.56	5.72	5.84	5.84
10,000	0.53	1.02	1.49	1.85	2.19	2.49	3.63	4.02	4.22	4.83	5.32	5.47	5.57	5.57
15,000	0.49	0.93	1.36	1.69	1.98	2.23	3.27	3.66	3.85	4.50	4.99	5.13	5.23	5.23
20,000	0.46	0.87	1.26	1.58	1.83	2.06	3.04	3.41	3.60	4.23	4.72	4.89	4.99	4.99
35,000	0.39	0.75	1.09	1.34	1.55	1.76	2.59	2.91	3.13	3.76	4.21	4.36	4.44	4.44
50,000	0.34	0.64	0.93	1.15	1.33	1.51	2.25	2.53	2.73	3.30	3.71	3.86	3.96	3.96
50,743	0.33	0.64	0.92	1.14	1.32	1.49	2.23	2.51	2.71	3.27	3.68	3.83	3.92	3.92



SPAS 1630 Storm Center Mass Curve Zone 1
October 13 (0600UTC) to October 18 (0500UTC), 1954
Lat: 43.8375 Lon: -79.9792

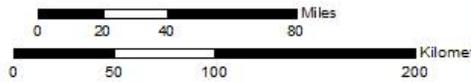




Total Storm (120-hr) Precipitation (inches)
10/13/1954 0600 UTC - 10/18/1954 0500 UTC
SPAS #1630

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental



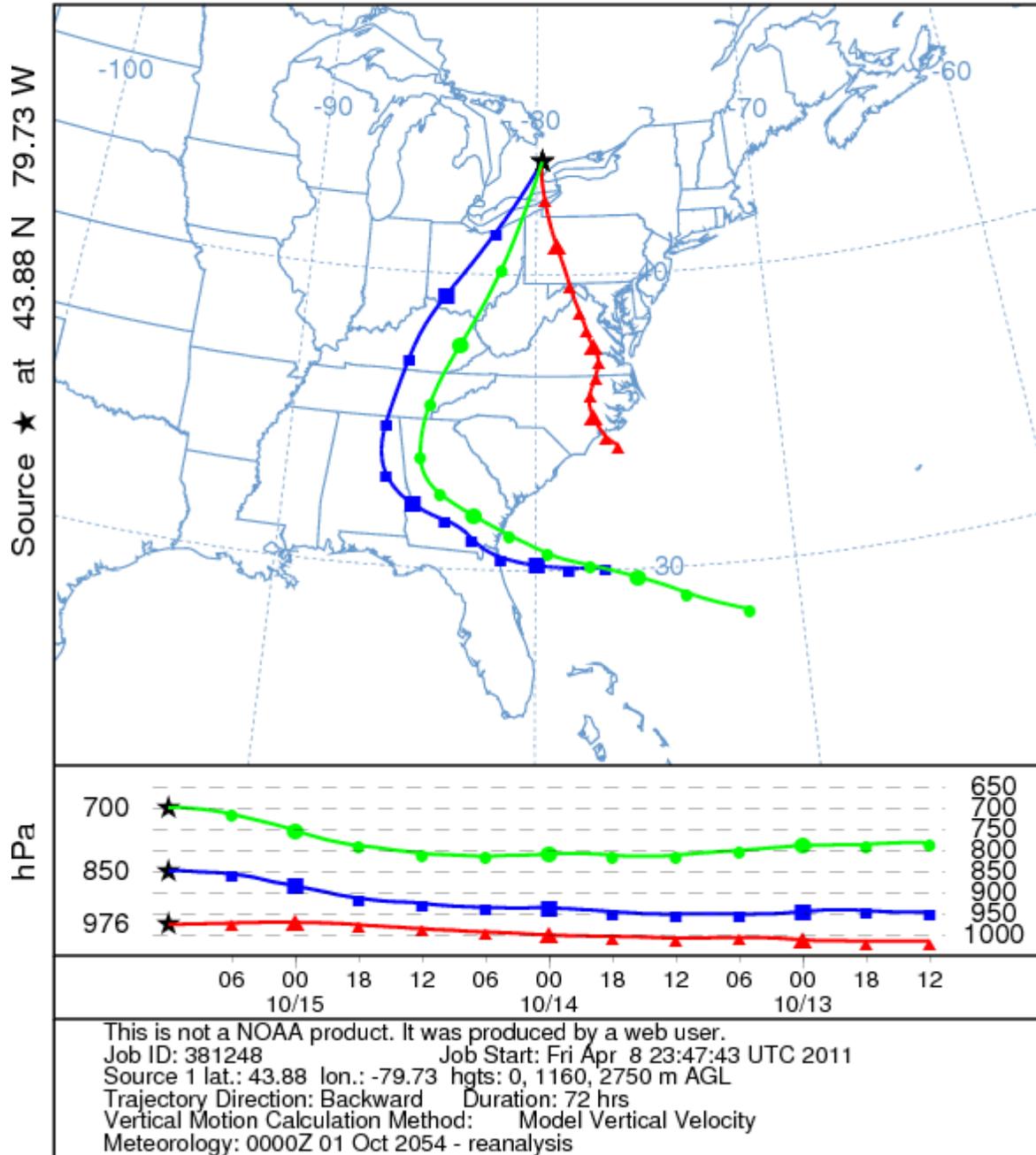
Precipitation (inches)

- | | | | |
|---------------|---------------|----------------|-----------------|
| ■ 1.12 - 2.00 | ■ 4.01 - 5.00 | ■ 7.01 - 8.00 | □ 10.01 - 12.00 |
| ■ 2.01 - 3.00 | ■ 5.01 - 6.00 | ■ 8.01 - 9.00 | |
| ■ 3.01 - 4.00 | ■ 6.01 - 7.00 | ■ 9.01 - 10.00 | |



10/10/2016

NOAA HYSPLIT MODEL Backward trajectories ending at 1200 UTC 15 Oct 54 CDC1 Meteorological Data



Storm Precipitation Analysis System (SPAS) For Storm #1504_1 SPAS Analysis

General Storm Location: Pelican Mtn, Alberta

Storm Dates: June 26 - July 2, 1970

Event: Synoptic/Convective Event

DAD Zone 1

Latitude: 55.5542°

Longitude: -113.6625°

Max. Grid Rainfall Amount: 286mm

Max. Observed Rainfall Amount: 266mm

Number of Stations: 524 (385 Daily, 37 Hourly, 13 Hourly Pseudo, 0 Hourly Estimated Pseudo, and 89 Supplemental)

SPAS Version: 10.0

Basemap: Blended PRISM July 1961-1990 Climatology (Canada) and AL 6-70 Isohyetal

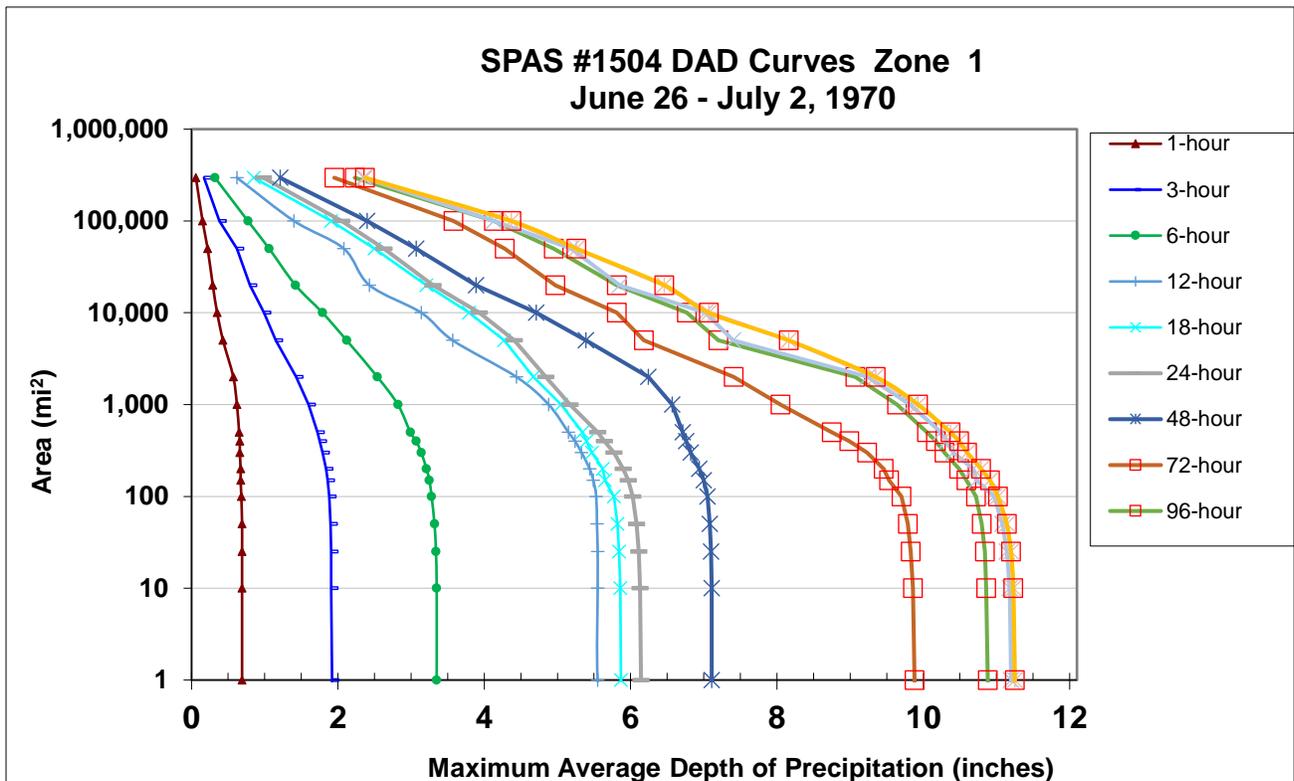
Spatial resolution: 30 second (degree: minute: second, WGS84, ~ 0.3 mi², 0.78 km²)

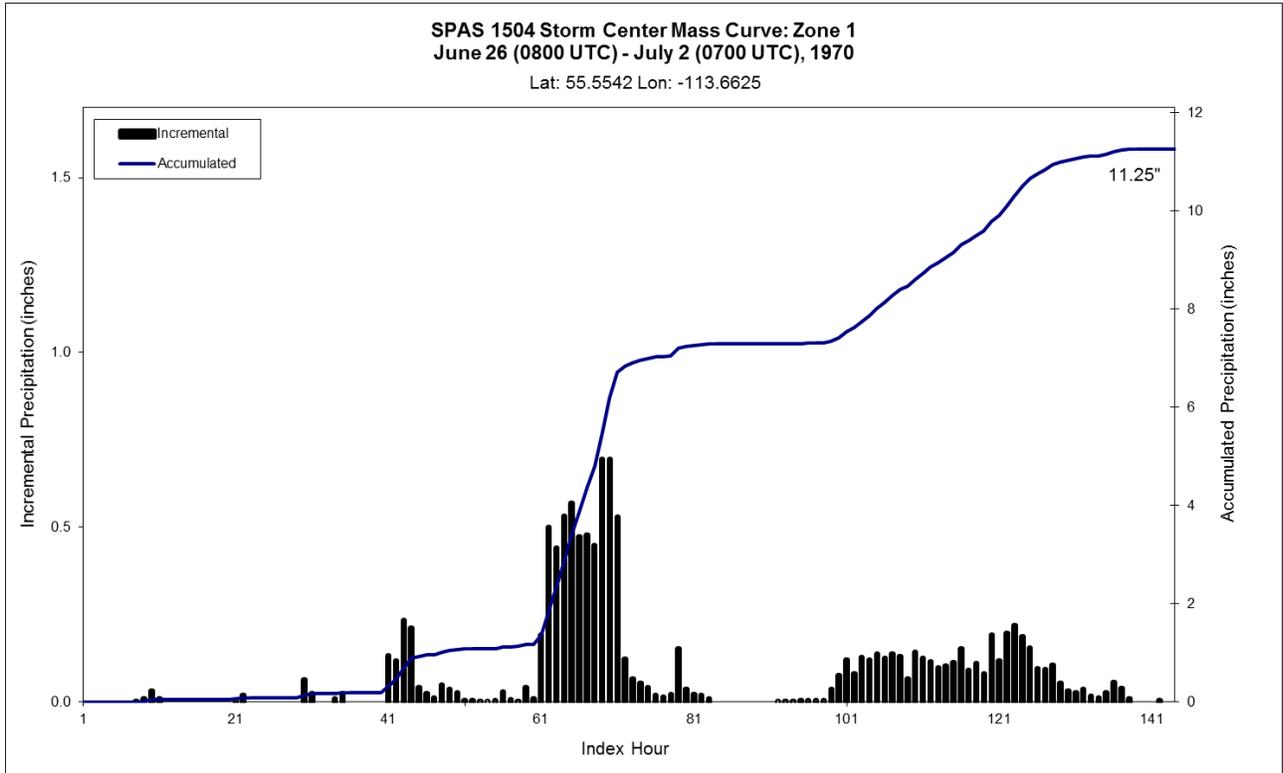
Radar Included: No

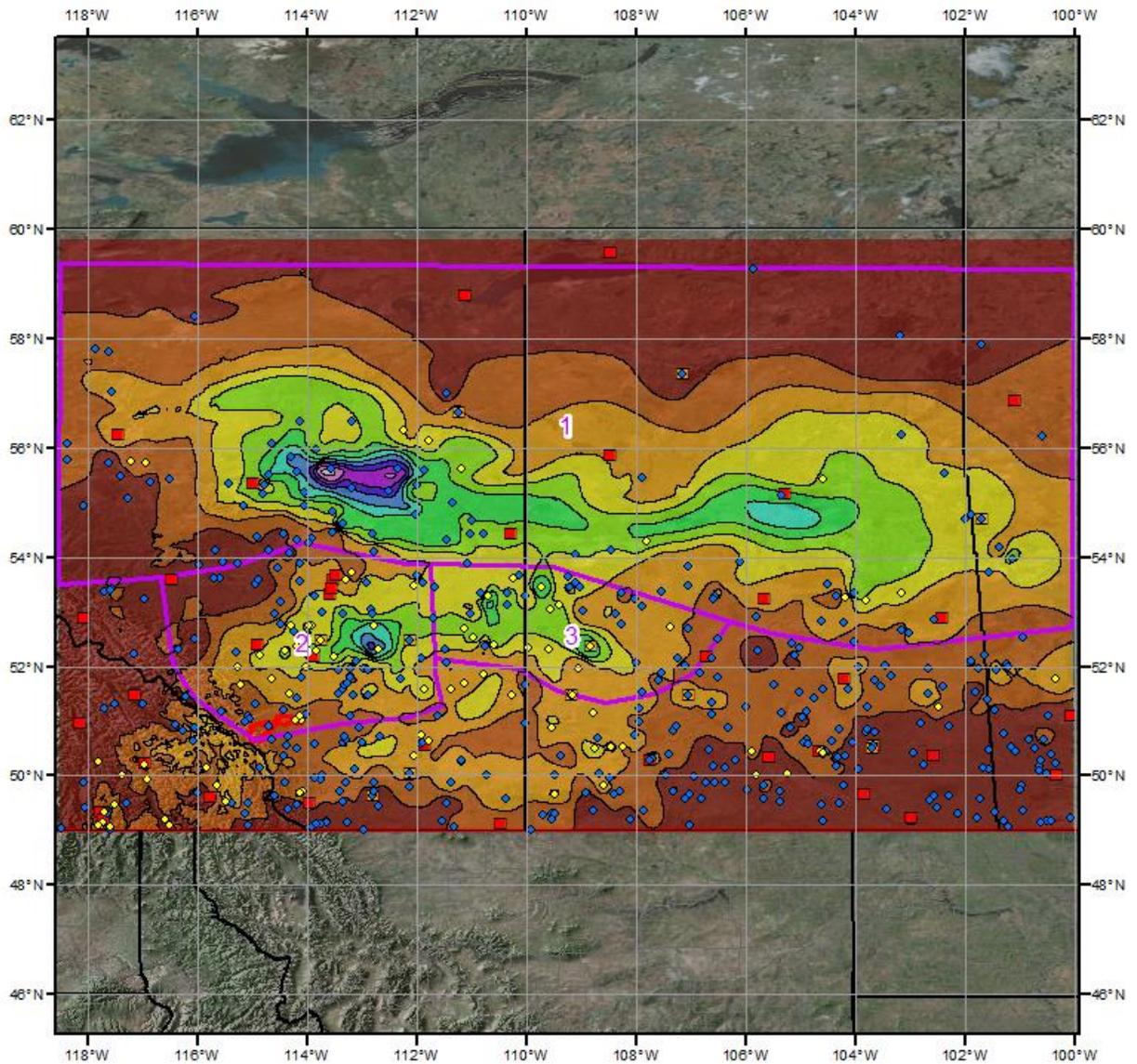
Depth-Area-Duration (DAD) analysis: Yes

Reliability of results: This analysis was based on hourly data, daily data, supplemental station data and AL 6-70 data. We have a good degree of confidence in the station based storm total results; the spatial pattern is dependent on the station data and a basemap. The timing is based on hourly and hourly pseudo stations.

Storm 1504 - June 26 (0800 UTC) - July 2 (0700 UTC), 1970												
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)												
Area (mi ²)	Duration (hours)											
	1	3	6	12	18	24	48	72	96	120	144	Total
0.2	0.69	1.92	3.35	5.67	5.89	6.16	7.22	9.92	10.95	11.20	11.25	11.25
1	0.69	1.92	3.35	5.55	5.87	6.14	7.11	9.88	10.88	11.20	11.25	11.25
10	0.69	1.91	3.35	5.55	5.86	6.13	7.11	9.86	10.86	11.18	11.23	11.23
25	0.69	1.91	3.34	5.55	5.84	6.11	7.10	9.83	10.84	11.14	11.20	11.20
50	0.69	1.90	3.32	5.54	5.82	6.08	7.08	9.79	10.80	11.08	11.14	11.14
100	0.68	1.88	3.28	5.53	5.77	6.03	7.05	9.70	10.72	10.97	11.02	11.02
150	0.67	1.86	3.25	5.49	5.65	5.97	7.00	9.53	10.59	10.73	10.91	10.91
200	0.67	1.84	3.21	5.44	5.62	5.90	6.94	9.46	10.49	10.68	10.79	10.79
300	0.66	1.79	3.14	5.33	5.47	5.77	6.82	9.23	10.29	10.41	10.60	10.60
400	0.66	1.75	3.07	5.24	5.40	5.64	6.76	8.99	10.17	10.32	10.49	10.49
500	0.65	1.72	2.99	5.15	5.34	5.55	6.71	8.75	10.05	10.24	10.37	10.37
1,000	0.62	1.60	2.82	4.88	5.05	5.17	6.57	8.05	9.64	9.82	9.93	9.93
2,000	0.57	1.43	2.54	4.44	4.67	4.84	6.24	7.41	9.07	9.24	9.35	9.35
5,000	0.43	1.15	2.12	3.57	4.27	4.41	5.39	6.18	7.20	7.40	8.16	8.16
10,000	0.35	0.99	1.79	3.14	3.79	3.93	4.71	5.81	6.77	7.02	7.07	7.07
20,000	0.29	0.80	1.42	2.43	3.21	3.30	3.89	4.97	5.81	5.85	6.46	6.46
50,000	0.22	0.62	1.06	2.08	2.50	2.63	3.07	4.28	4.95	5.19	5.26	5.26
100,000	0.15	0.38	0.77	1.40	1.91	2.05	2.40	3.58	4.13	4.13	4.37	4.37
295,706	0.06	0.17	0.32	0.62	0.85	0.98	1.21	1.95	2.23	2.35	2.37	2.37



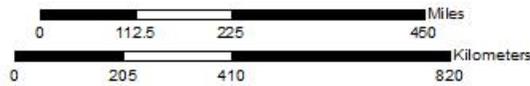




Total Storm (144-hr) Precipitation (inches)
6/26/1970 (0800 UTC) - 7/02/1970 (0700 UTC)
SPAS 1504

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental



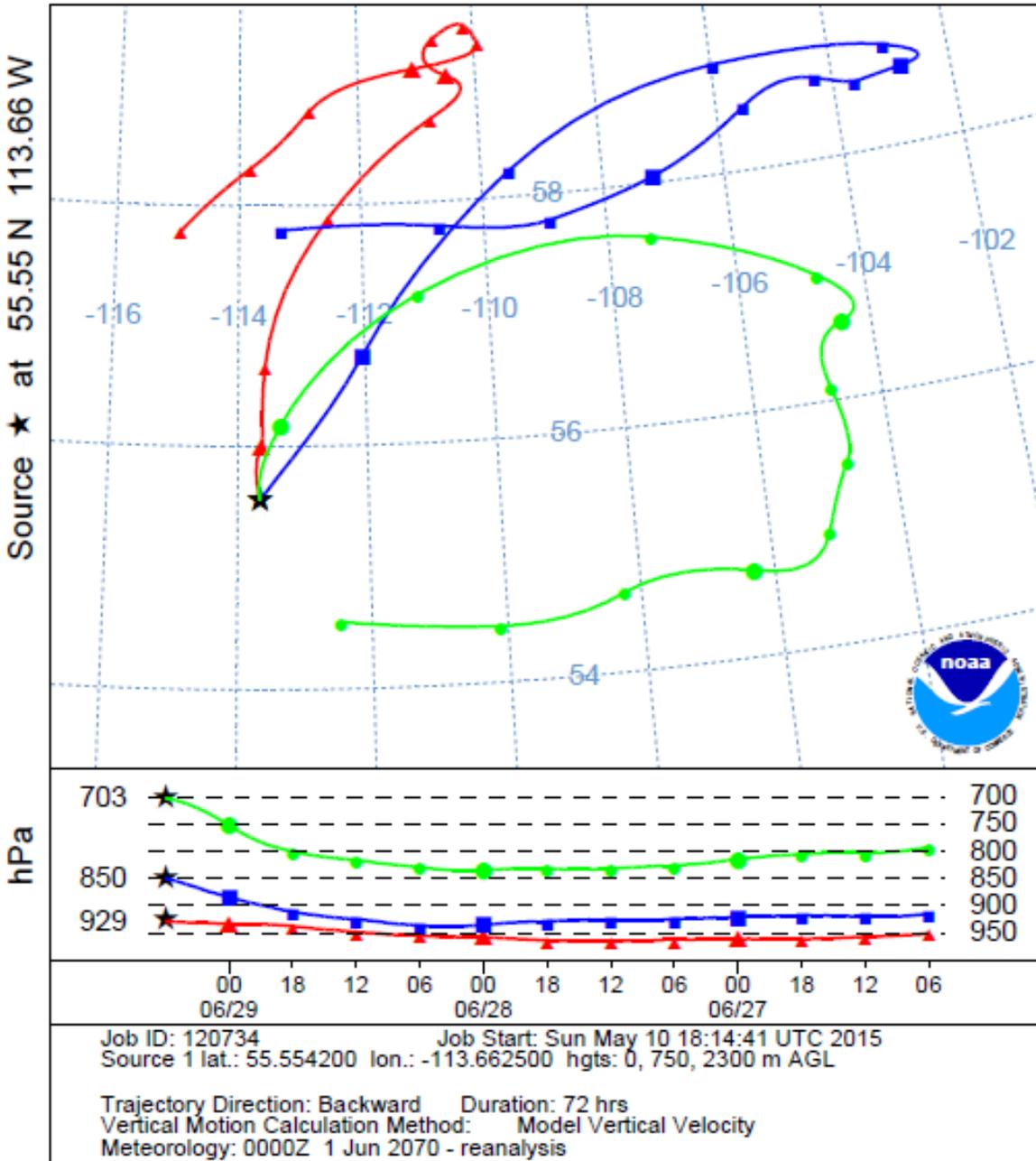
Precipitation (inches)

■ 0.00 - 1.00	■ 3.01 - 4.00	■ 6.01 - 7.00	■ 9.01 - 10.00
■ 1.01 - 2.00	■ 4.01 - 5.00	■ 7.01 - 8.00	■ 10.01 - 11.00
■ 2.01 - 3.00	■ 5.01 - 6.00	■ 8.01 - 9.00	■ 11.01 - 12.00

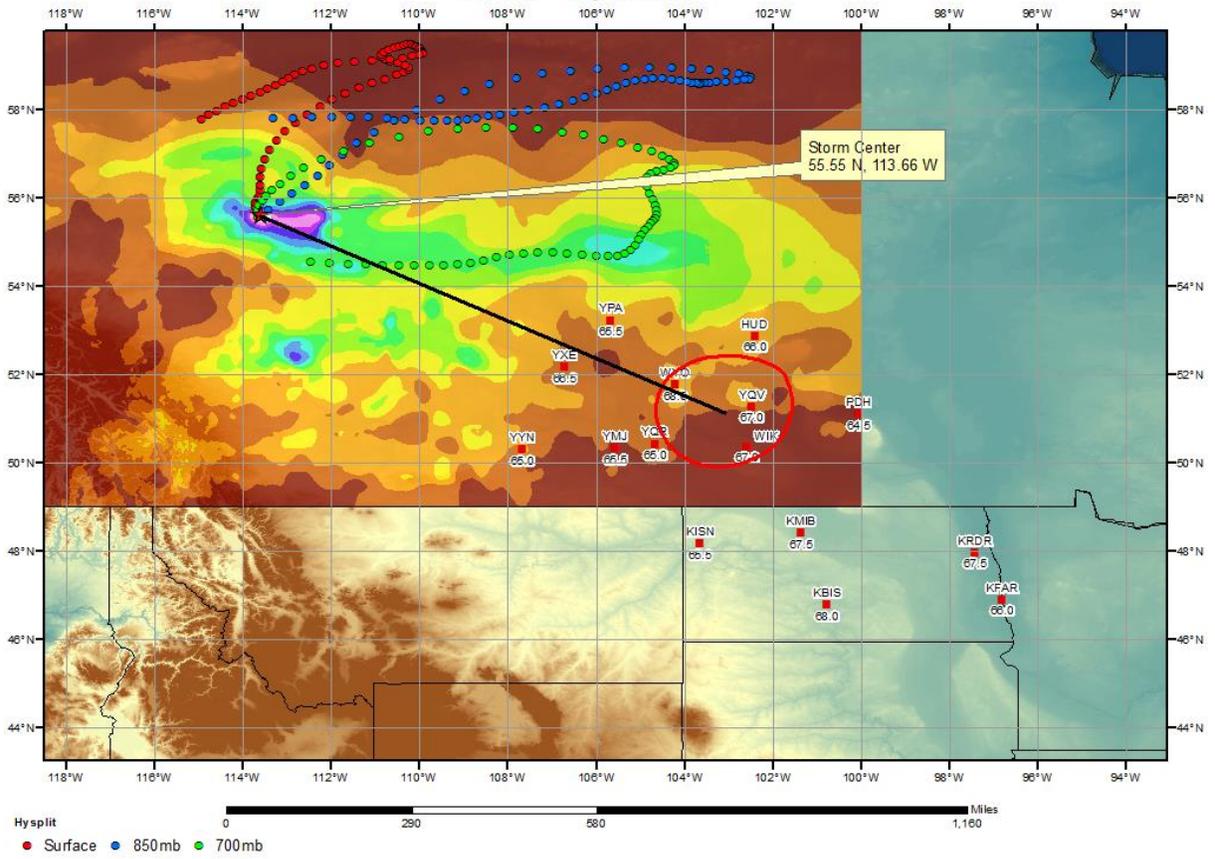


5/01/2015

NOAA HYSPLIT MODEL
 Backward trajectories ending at 0600 UTC 29 Jun 70
 CDC1 Meteorological Data



SPAS 1504 Pelican Mtn, AB Storm Analysis June 28 - July 1, 1970



Storm Precipitation Analysis System (SPAS) For Storm #1738_1 SPAS Analysis

General Storm Location: Harlan, IA

Storm Dates: September 9-14, 1972

Event: Synoptic/Warm Front

DAD Zone 1

Latitude: 41.7208

Longitude: -95.2125

Max. Grid Rainfall Amount: 15.81"

Max. Observed Rainfall Amount: 15.25"

Number of Stations: 1081

SPAS Version: 10.0

Base Map Used: Blend of PRISM climatology from Sept 1972 and CONUS 30-yr climatology

Spatial resolution: 0.2479

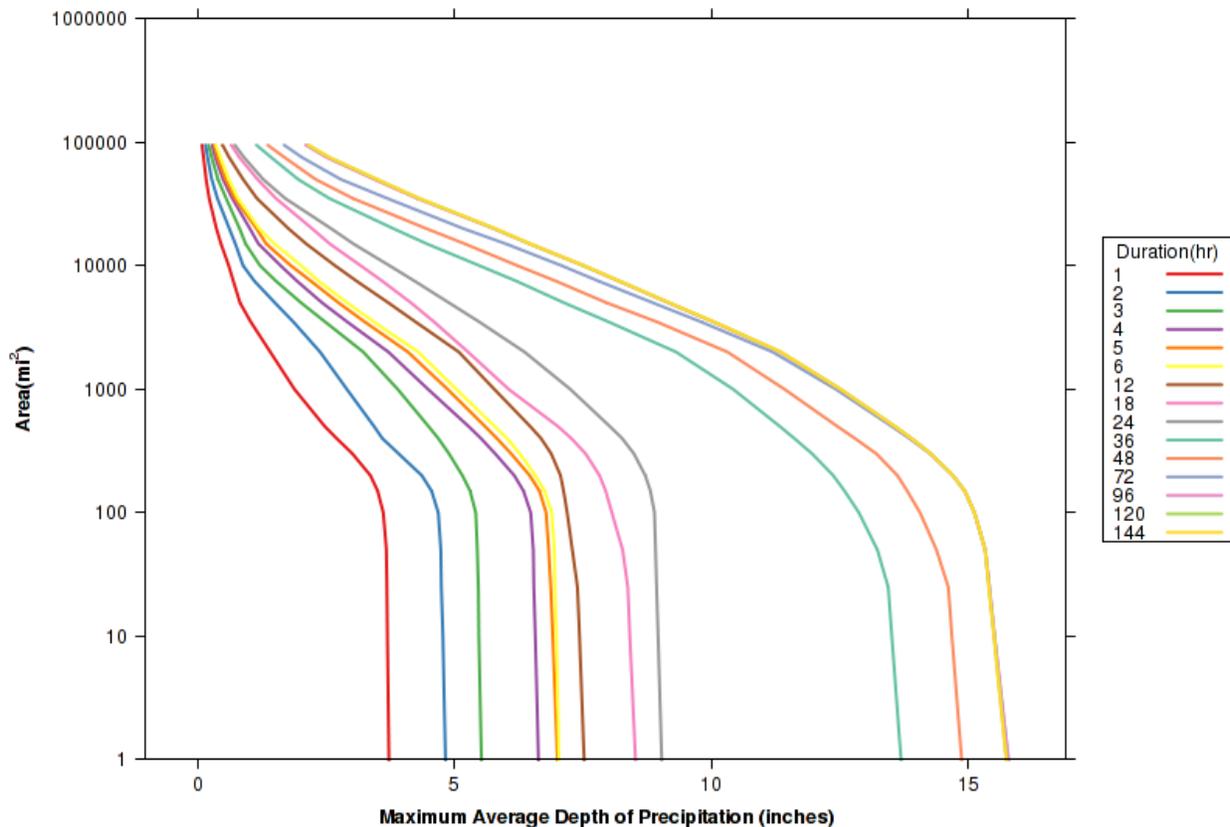
Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes

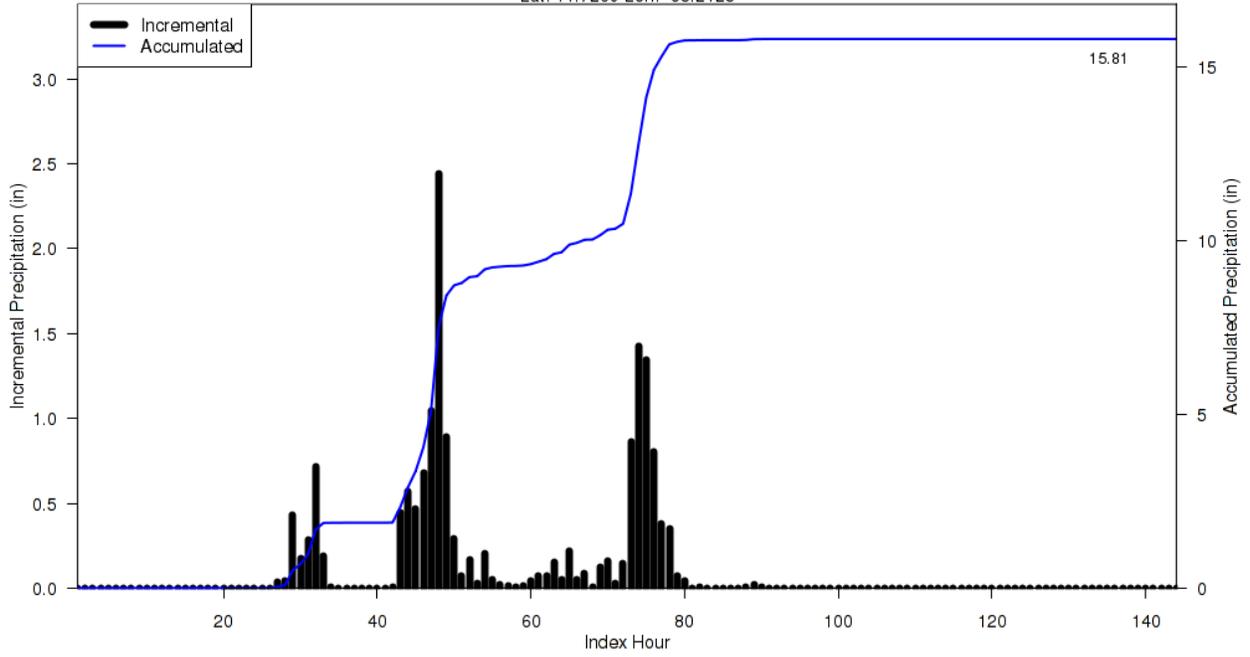
Degree of confidence in results: This analysis was based on 1081 hourly stations, daily data, and supplemental station data. We have a good degree of confidence for the station based storm total results. The spatial pattern is fully dependent on the blended basemap. Timing is based on the hourly and hourly pseudo stations. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

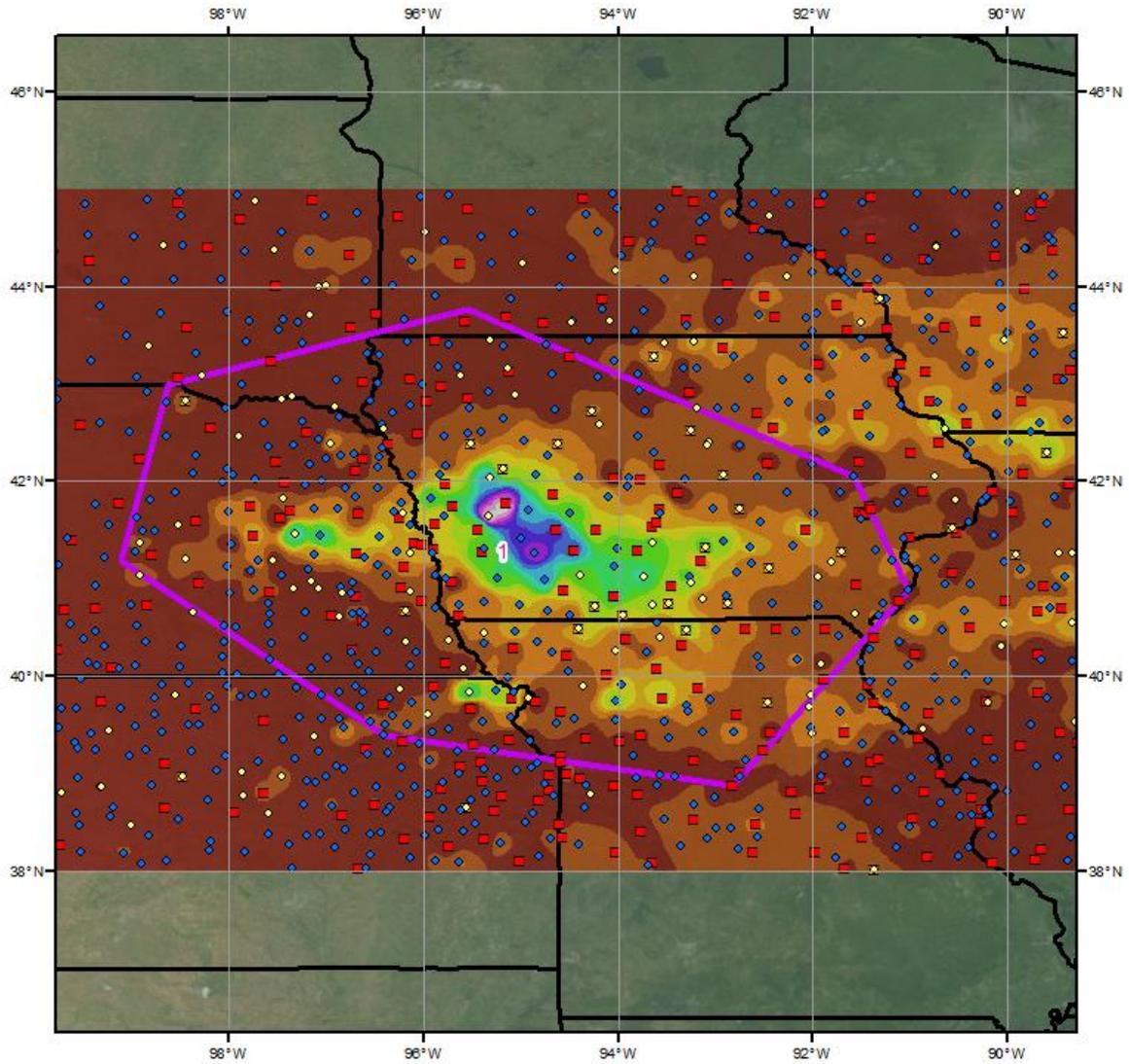
SPAS 1738 - September 9 (0700 UTC) - September 15 (0600 UTC), 1972										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	6	12	24	48	72	96	120	144	Total
0.4	3.72	7.05	7.55	9.06	14.94	15.81	15.81	15.81	15.81	15.81
1	3.72	7.03	7.52	9.03	14.87	15.78	15.78	15.74	15.74	15.74
10	3.69	6.98	7.43	8.96	14.68	15.51	15.51	15.50	15.50	15.50
25	3.68	6.95	7.39	8.93	14.61	15.41	15.41	15.40	15.40	15.40
50	3.67	6.94	7.29	8.91	14.38	15.33	15.33	15.33	15.33	15.33
100	3.61	6.89	7.19	8.89	14.06	15.12	15.12	15.12	15.12	15.12
200	3.36	6.57	7.06	8.71	13.62	14.70	14.70	14.70	14.70	14.70
300	3.01	6.27	6.88	8.49	13.21	14.26	14.27	14.27	14.27	14.27
400	2.70	6.02	6.68	8.26	12.79	13.85	13.89	13.89	13.89	13.89
500	2.47	5.78	6.47	8.02	12.45	13.51	13.56	13.57	13.57	13.57
1,000	1.88	5.03	5.77	7.25	11.42	12.42	12.50	12.51	12.51	12.51
2,000	1.41	4.29	5.08	6.36	10.31	11.19	11.33	11.35	11.35	11.35
5,000	0.82	2.91	3.71	4.89	7.96	8.86	9.16	9.18	9.18	9.18
10,000	0.60	2.01	2.67	3.73	6.22	7.08	7.50	7.51	7.52	7.52
20,000	0.36	1.19	1.76	2.59	4.44	5.16	5.75	5.77	5.78	5.78
50,000	0.16	0.60	0.88	1.27	2.29	2.78	3.43	3.48	3.49	3.49
94,561	0.08	0.35	0.48	0.72	1.36	1.68	2.10	2.15	2.15	2.15

SPAS 1738 DAD Curves Zone 1
September 9 (0700UTC) to September 15 (0600UTC), 1972



SPAS 1738 Storm Center Mass Curve Zone 1
September 9 (0700UTC) to September 15 (0600UTC), 1972
Lat: 41.7208 Lon: -95.2125

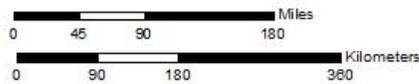




Total Storm (144-hours) Precipitation (inches)
September 9-14, 1972
SPAS 1738 - Harlan, IA

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental

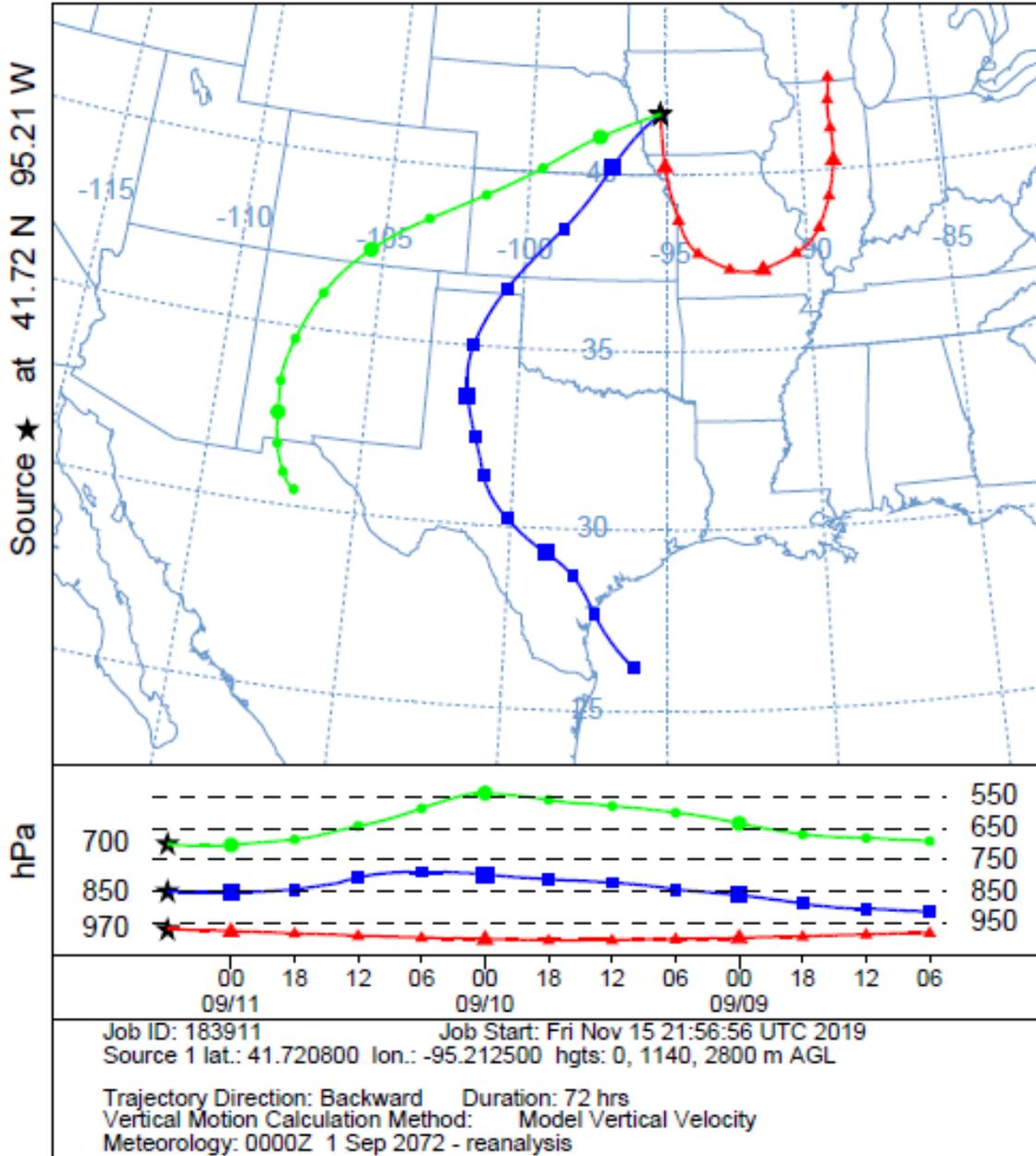


Precipitation (inches)

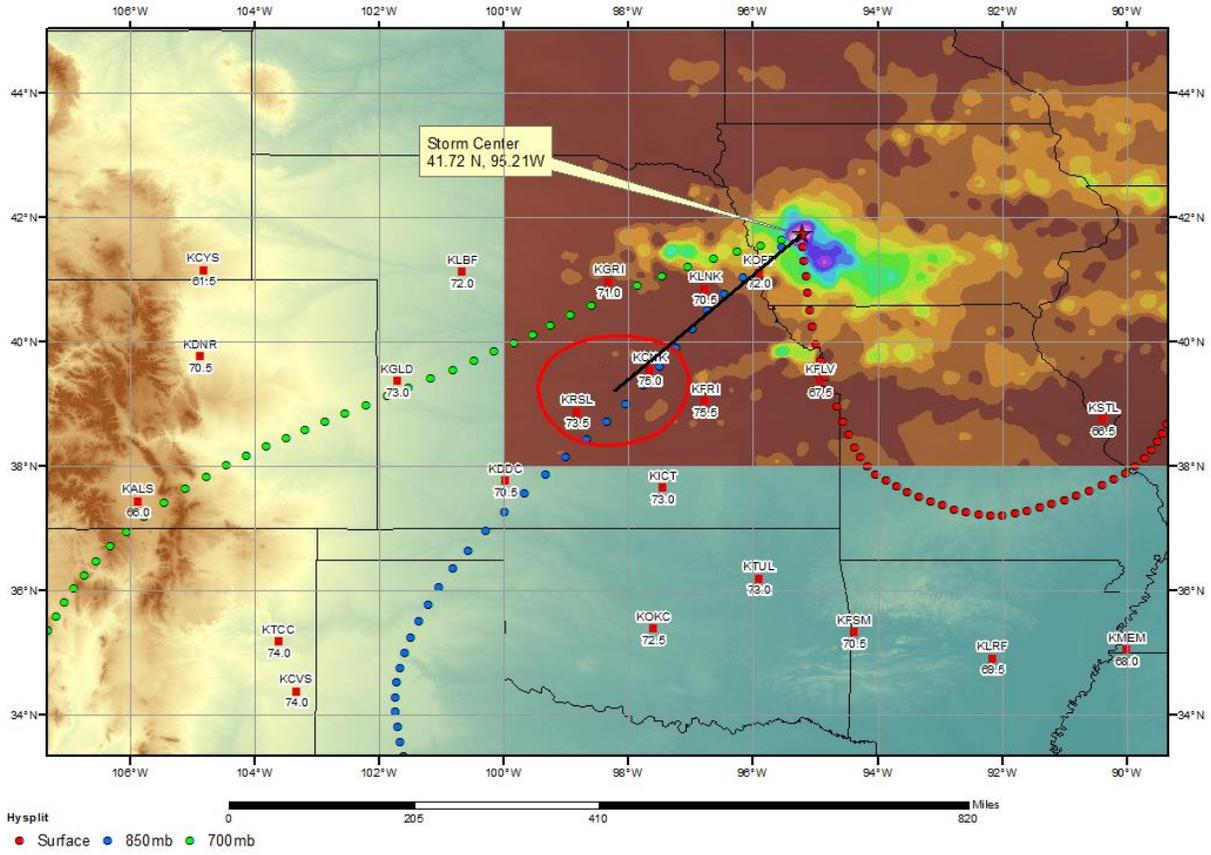
0.00 - 1.00	5.01 - 6.00	11.01 - 12.00
1.01 - 2.00	6.01 - 7.00	12.01 - 13.00
2.01 - 3.00	7.01 - 8.00	13.01 - 14.00
3.01 - 4.00	8.01 - 9.00	14.01 - 15.00
4.01 - 5.00	9.01 - 10.00	15.01 - 16.00
	10.01 - 11.00	



NOAA HYSPLIT MODEL
 Backward trajectories ending at 0600 UTC 11 Sep 72
 CDC1 Meteorological Data



SPAS 1738 Storm Analysis September 10-11, 1972



Storm Precipitation Analysis System (SPAS) For Storm #1502_1 SPAS Analysis

General Storm Location: Sedalia, Alberta

Storm Dates: June 13 - 18, 1973

Event: Synoptic/Convective Event

DAD Zone 1

Latitude: 51.8625°

Longitude: -110.4292°

Max. Grid Rainfall Amount: 243mm

Max. Observed Rainfall Amount: 223mm

Number of Stations: 299 (223 Daily, 20 Hourly, 10 Hourly Pseudo, 0 Hourly Estimated Pseudo, and 46 Supplemental)

SPAS Version: 10.0

Basemap: Blended PRISM July 1961-1990 Climatology (Canada) and AL 6-73 Isohyetal

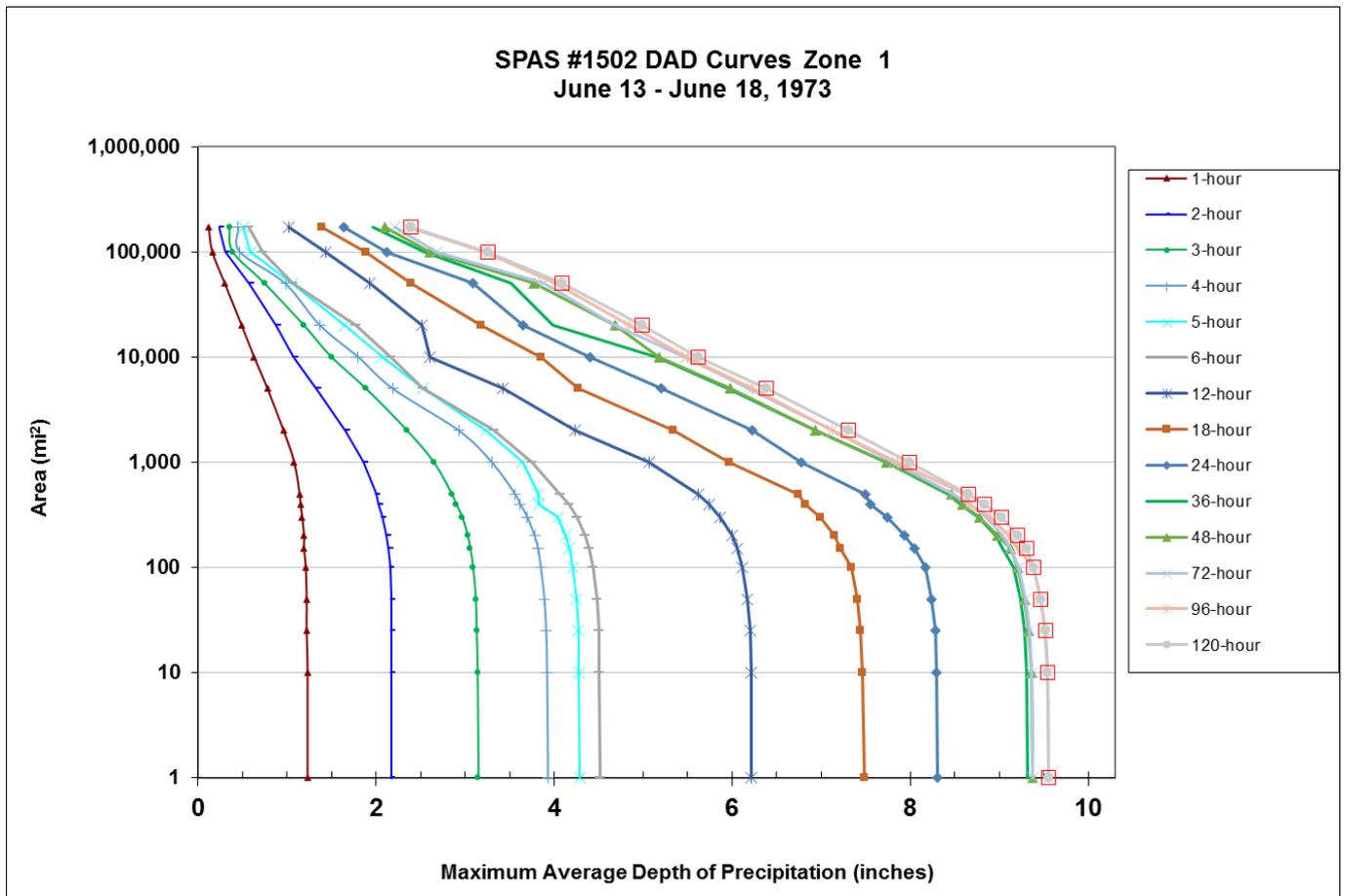
Spatial resolution: 30 second (degree: minute: second, WGS84, ~ 0.3 mi², 0.78 km²)

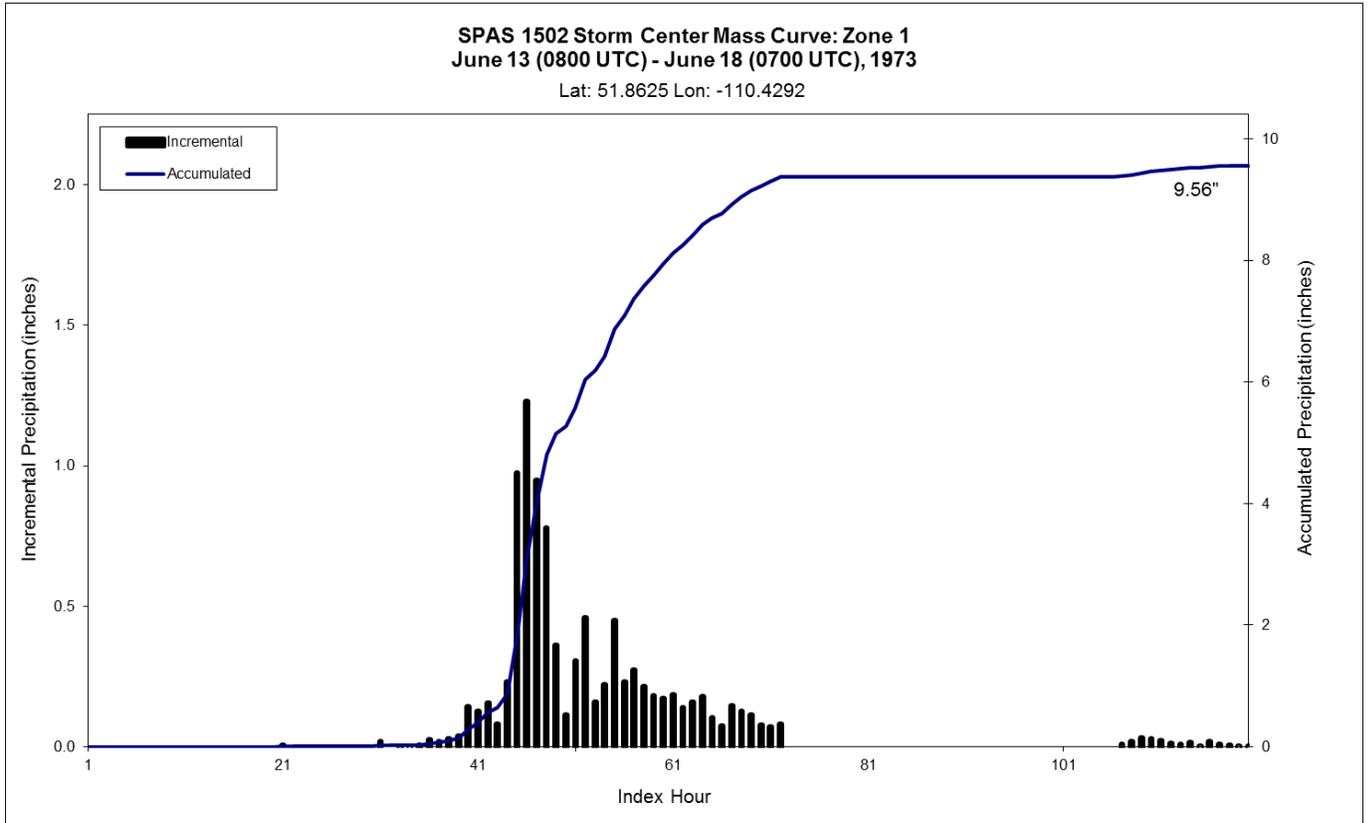
Radar Included: No

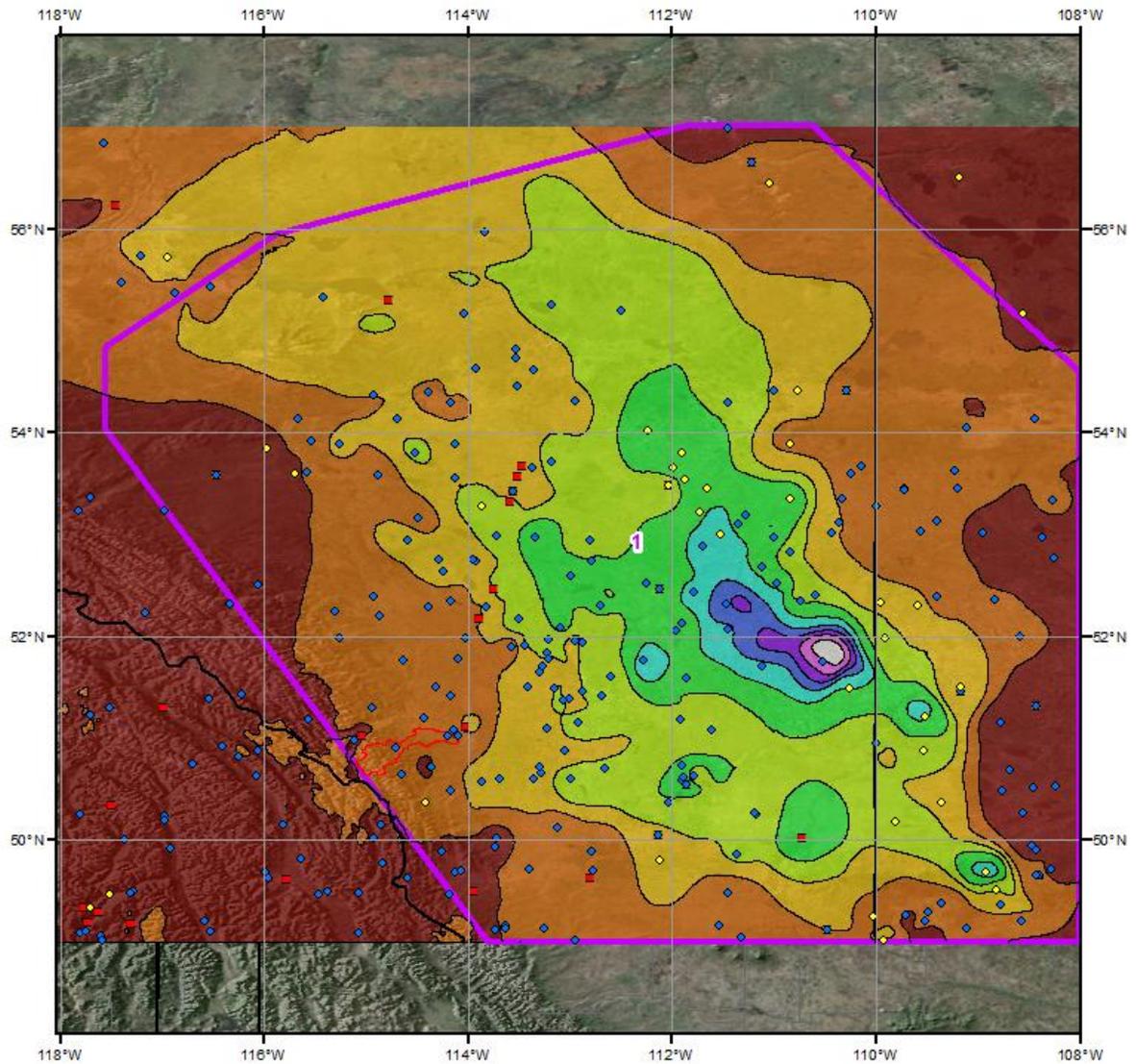
Depth-Area-Duration (DAD) analysis: Yes

Reliability of results: This analysis was based on hourly data, daily data, supplemental station data and AL 6-73 data. We have a good degree of confidence in the station based storm total results; the spatial pattern is dependent on the station data and a basemap. The timing is based on hourly and hourly pseudo stations.

Storm 1502 - June 13 (0800 UTC) - June 18 (0700 UTC), 1973															
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)															
Area (mi ²)	Duration (hours)														
	1	2	3	4	5	6	12	18	24	36	48	72	96	120	Total
0.2	1.23	2.20	3.15	3.93	4.29	4.52	6.22	7.48	8.31	9.32	9.37	9.38	9.55	9.56	9.56
1	1.23	2.17	3.15	3.93	4.29	4.52	6.22	7.48	8.31	9.32	9.37	9.38	9.55	9.56	9.56
10	1.23	2.17	3.14	3.92	4.28	4.51	6.21	7.46	8.30	9.31	9.36	9.36	9.54	9.54	9.54
25	1.22	2.17	3.13	3.91	4.27	4.50	6.20	7.44	8.28	9.28	9.33	9.34	9.51	9.52	9.52
50	1.22	2.17	3.12	3.89	4.25	4.48	6.17	7.41	8.24	9.24	9.29	9.30	9.47	9.47	9.47
100	1.21	2.16	3.09	3.85	4.21	4.44	6.11	7.34	8.17	9.16	9.21	9.22	9.39	9.39	9.39
150	1.19	2.14	3.06	3.82	4.17	4.39	6.06	7.22	8.05	9.04	9.13	9.13	9.21	9.31	9.31
200	1.19	2.12	3.03	3.78	4.13	4.35	6.00	7.15	7.94	8.96	8.98	9.04	9.11	9.21	9.21
300	1.17	2.07	2.97	3.70	4.04	4.26	5.87	6.99	7.74	8.77	8.78	8.86	8.90	9.03	9.03
400	1.15	2.03	2.90	3.62	3.83	4.17	5.74	6.82	7.55	8.57	8.59	8.67	8.67	8.84	8.84
500	1.14	2.00	2.85	3.56	3.82	4.07	5.62	6.74	7.50	8.43	8.46	8.49	8.62	8.65	8.65
1,000	1.08	1.86	2.65	3.30	3.64	3.75	5.07	5.97	6.78	7.73	7.73	7.81	7.86	7.99	7.99
2,000	0.96	1.66	2.35	2.93	3.24	3.32	4.23	5.34	6.23	6.93	6.93	7.13	7.13	7.31	7.31
5,000	0.78	1.33	1.89	2.19	2.53	2.53	3.43	4.27	5.20	5.94	5.98	6.18	6.23	6.38	6.38
10,000	0.63	1.07	1.50	1.80	2.07	2.17	2.61	3.85	4.40	5.16	5.18	5.47	5.50	5.62	5.62
20,000	0.49	0.88	1.19	1.37	1.65	1.77	2.51	3.18	3.65	3.99	4.68	4.68	4.84	4.99	4.99
50,000	0.30	0.58	0.75	0.98	1.06	1.06	1.93	2.39	3.09	3.52	3.77	3.89	4.01	4.09	4.09
100,000	0.16	0.31	0.39	0.47	0.59	0.73	1.43	1.88	2.12	2.55	2.61	2.68	3.22	3.26	3.26
170,226	0.12	0.24	0.35	0.45	0.51	0.57	1.02	1.39	1.64	1.96	2.10	2.21	2.36	2.39	2.39



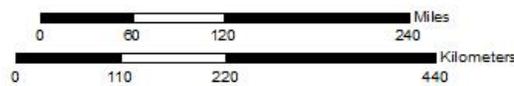




Total Storm (120-hr) Precipitation (inches)
6/13/1973 (0800 UTC) - 6/18/1973 (0700 UTC)
SPAS 1502

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◆ Supplemental



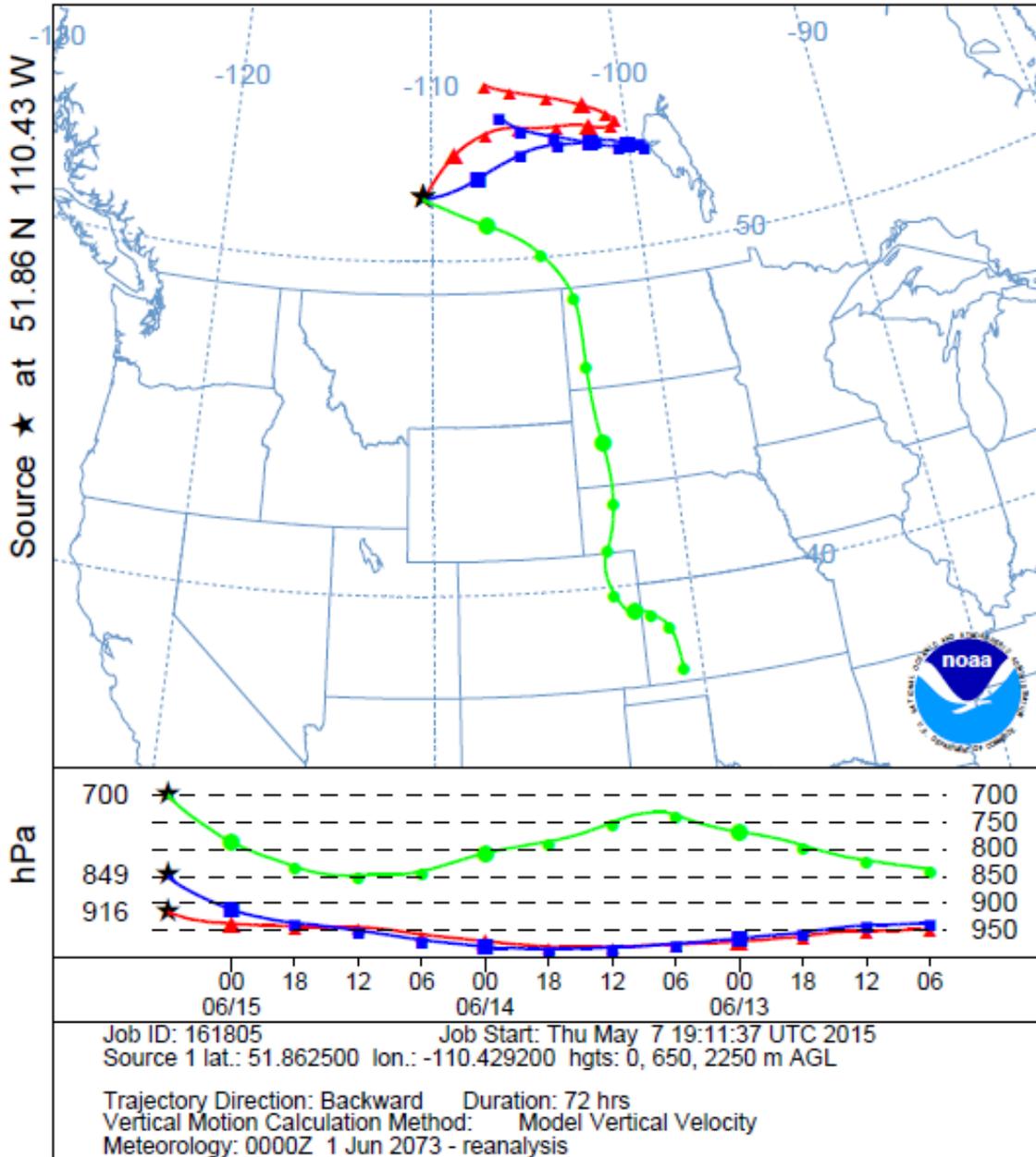
Precipitation (inches)

- | | | | | |
|---------------|---------------|---------------|---------------|----------------|
| ■ 0.03 - 1.00 | ■ 2.01 - 3.00 | ■ 4.01 - 5.00 | ■ 6.01 - 7.00 | ■ 8.01 - 9.00 |
| ■ 1.01 - 2.00 | ■ 3.01 - 4.00 | ■ 5.01 - 6.00 | ■ 7.01 - 8.00 | ■ 9.01 - 10.00 |

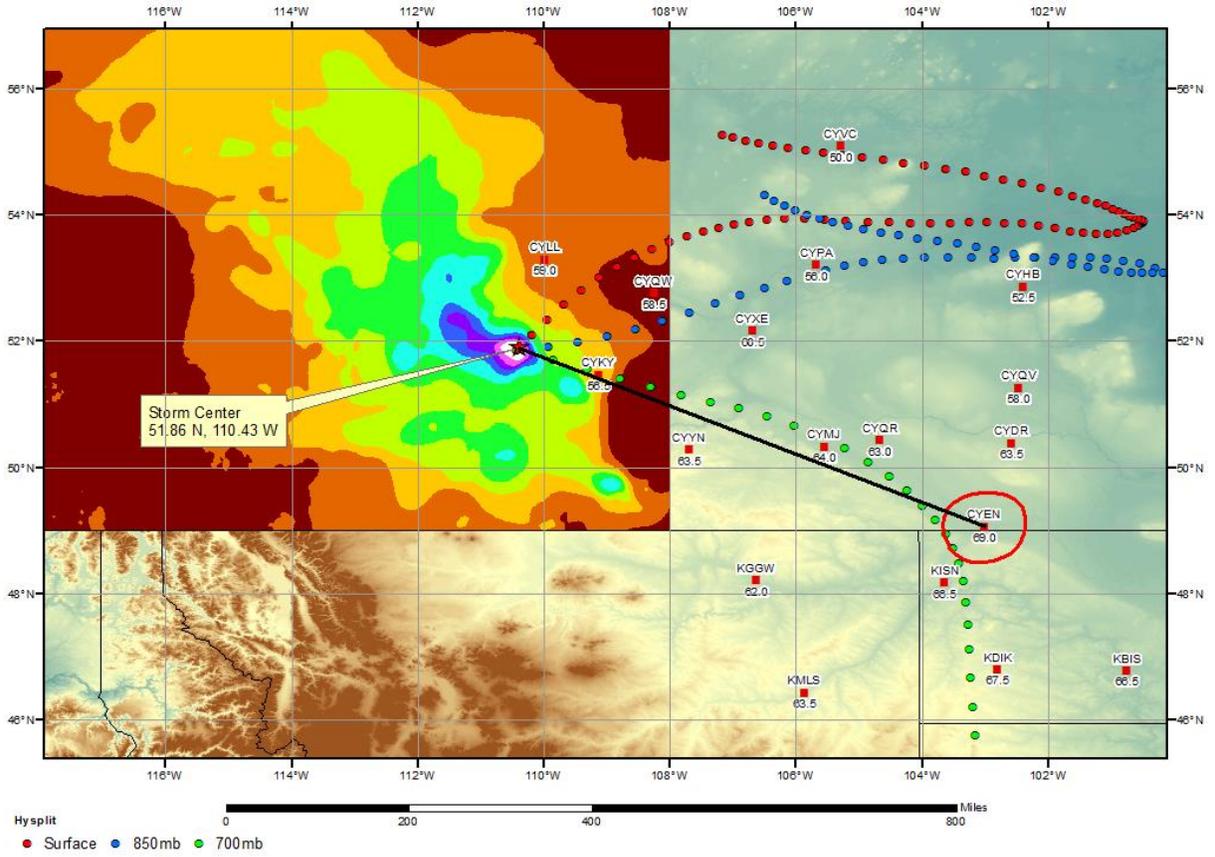


4/22/2015

NOAA HYSPLIT MODEL
 Backward trajectories ending at 0600 UTC 15 Jun 73
 CDC1 Meteorological Data



SPAS 1502 Sedalia, AB Storm Analysis June 13 - 16, 1973



Storm Precipitation Analysis System (SPAS) For Storm #1337_1 SPAS Analysis

General Storm Location: Wilson, Saskatchewan

Storm Dates: August 3-4, 1985

Event: Convective event

DAD Zone 1

Latitude: 49.7020°

Longitude: -101.8958°

Max. grid rainfall amount: 400mm

Max. observed rainfall amount: 381mm (Wilson, SK)

Number of Stations: 142

SPAS Version: 9.5

Base Map Used: Based on digitized Canadian Climate Centre of Environment Canada's SASK-8-85 Isohyetal Map (storm total)

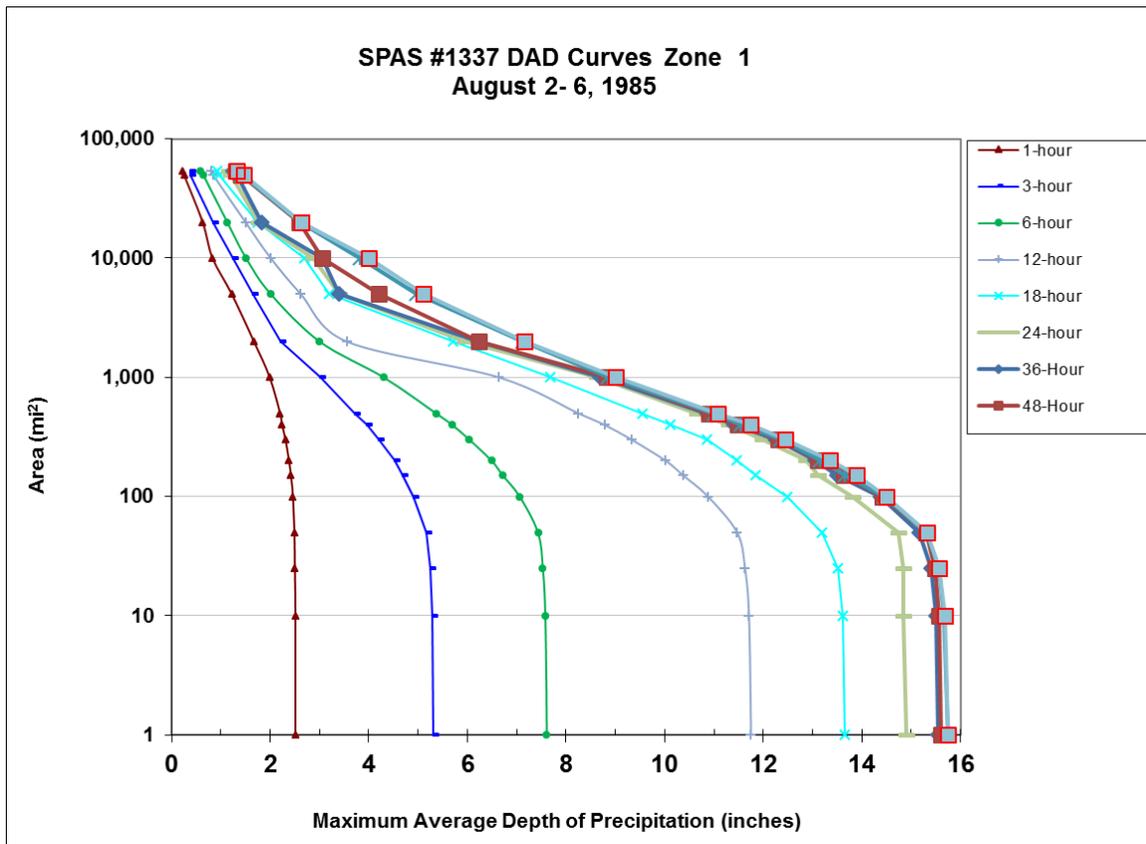
Spatial resolution: 30 seconds (decimal degrees, WGS84, ~ 0.30 mi², 0.78 km²)

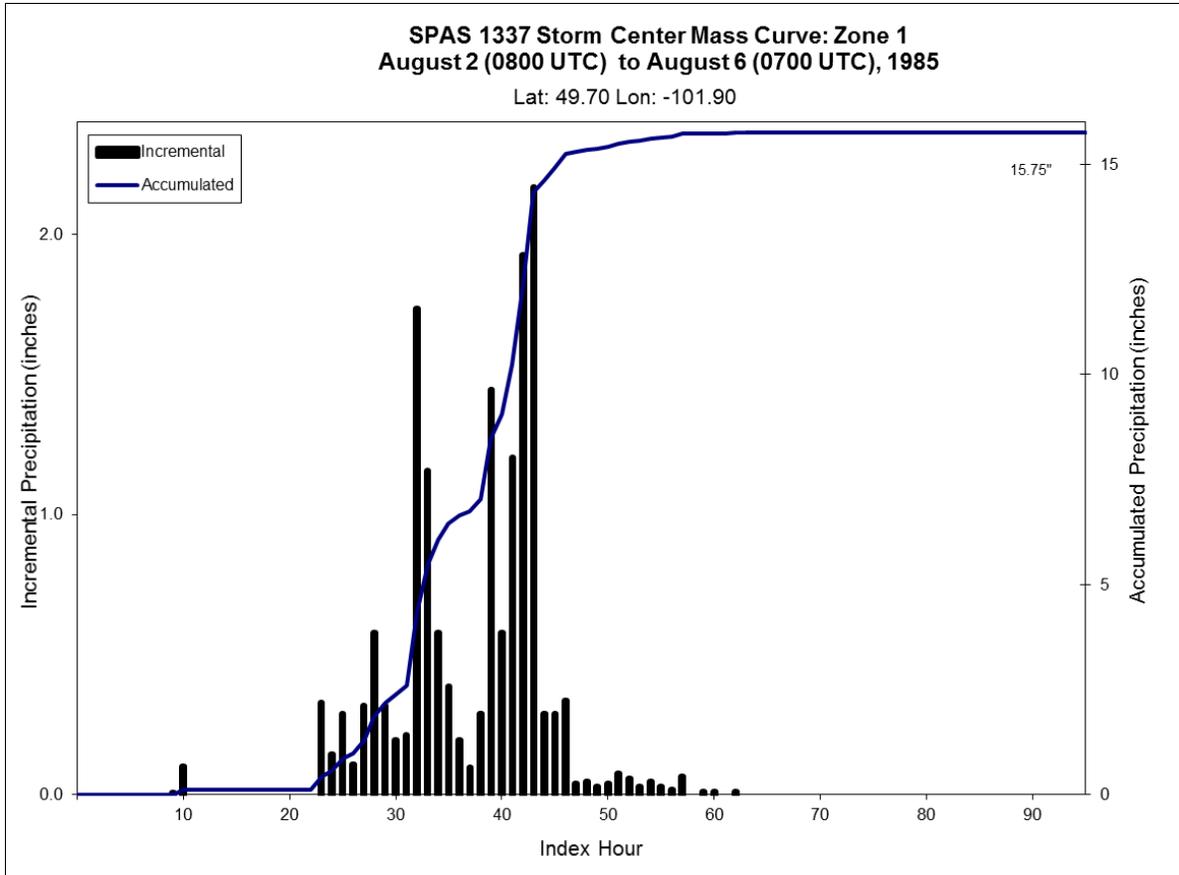
Radar Included: No

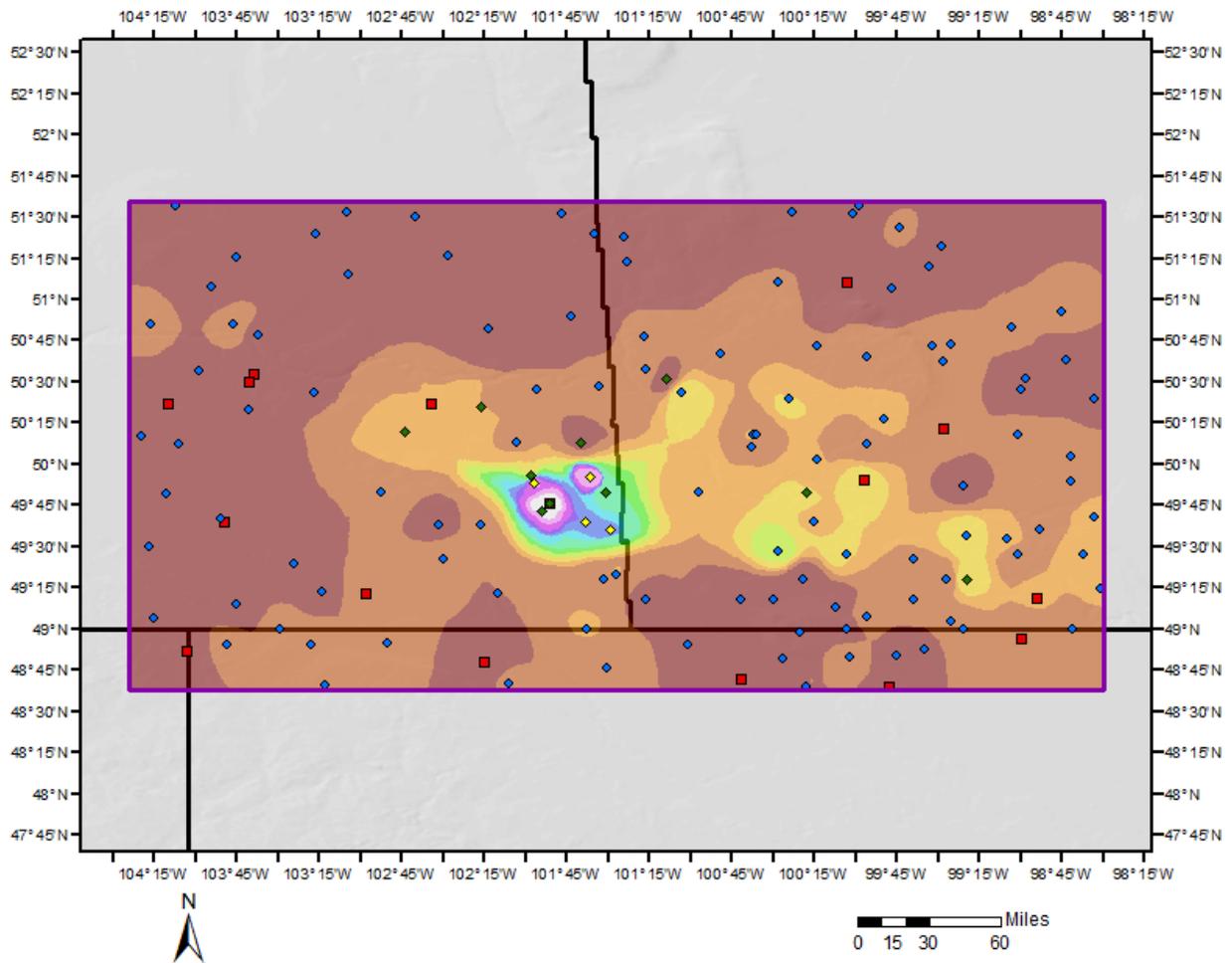
Depth-Area-Duration (DAD) analysis: Yes

Reliability of Results: Environment Canada was asked about the full storm report, SASK-8-85 for this event, but they could not locate the report. There were a limited number of recording gauges and none were located in or near the storm center. Estimates of the hourly data for the maximum daily observation at WILSON SK were developed. Effort was taken to conform the maximum 6-hour, 12-hour and 24-hour amounts to the "point" DAD amounts derived from the Environment Canada figure and consideration was given to the influence of the three nearest hourly stations (ESTEVAN AIRPORT SK, BROADVIEW SK, and BRANDON AIRPORT MB). The reliability of the timing has significant uncertainty as a result. Results are consistent with the published DAD estimates (those for 100 square miles are within +/- 2").

Storm 1337 - August 2 (0800 UTC) - August 6 (0700 UTC), 1985											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
Area (mi ²)	Duration (hours)										
	1	3	6	12	18	24	36	48	72	96	Total
0.2	2.51	5.30	7.61	11.75	13.66	15.15	15.62	15.72	15.75	15.75	15.75
1	2.51	5.30	7.61	11.75	13.66	14.90	15.55	15.61	15.74	15.74	15.74
10	2.51	5.28	7.58	11.71	13.61	14.85	15.50	15.56	15.67	15.68	15.68
25	2.50	5.24	7.53	11.63	13.51	14.84	15.41	15.48	15.56	15.56	15.56
50	2.49	5.17	7.43	11.47	13.20	14.75	15.17	15.30	15.30	15.33	15.33
100	2.46	4.90	7.06	10.88	12.48	13.81	14.37	14.42	14.46	14.50	14.50
150	2.42	4.69	6.72	10.38	11.85	13.11	13.49	13.63	13.65	13.90	13.90
200	2.38	4.52	6.49	10.02	11.47	12.87	13.05	13.12	13.16	13.36	13.36
300	2.31	4.21	6.04	9.33	10.85	11.99	12.25	12.30	12.34	12.44	12.44
400	2.24	3.96	5.69	8.78	10.11	11.30	11.41	11.49	11.55	11.74	11.74
500	2.20	3.72	5.36	8.25	9.56	10.65	10.86	10.89	11.00	11.07	11.07
1,000	1.99	3.02	4.30	6.64	7.69	8.62	8.68	8.83	8.84	9.00	9.00
2,000	1.67	2.22	3.00	3.55	5.70	5.96	6.21	6.23	7.11	7.16	7.16
5,000	1.22	1.65	2.01	2.62	3.20	3.39	3.39	4.20	4.96	5.11	5.11
10,000	0.83	1.25	1.51	2.01	2.69	2.88	3.06	3.06	3.82	4.00	4.00
20,000	0.63	0.85	1.13	1.50	1.74	1.76	1.82	2.60	2.62	2.63	2.63
50,000	0.25	0.39	0.64	0.84	0.97	1.20	1.33	1.41	1.42	1.47	1.47
53,819	0.22	0.39	0.59	0.81	0.92	1.16	1.25	1.30	1.32	1.32	1.32

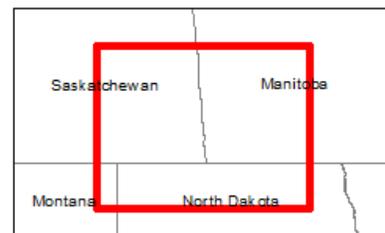






**Total 96-hr Precipitation (inches)
August 2-5, 1985 0800 UTC
SPAS #1337**

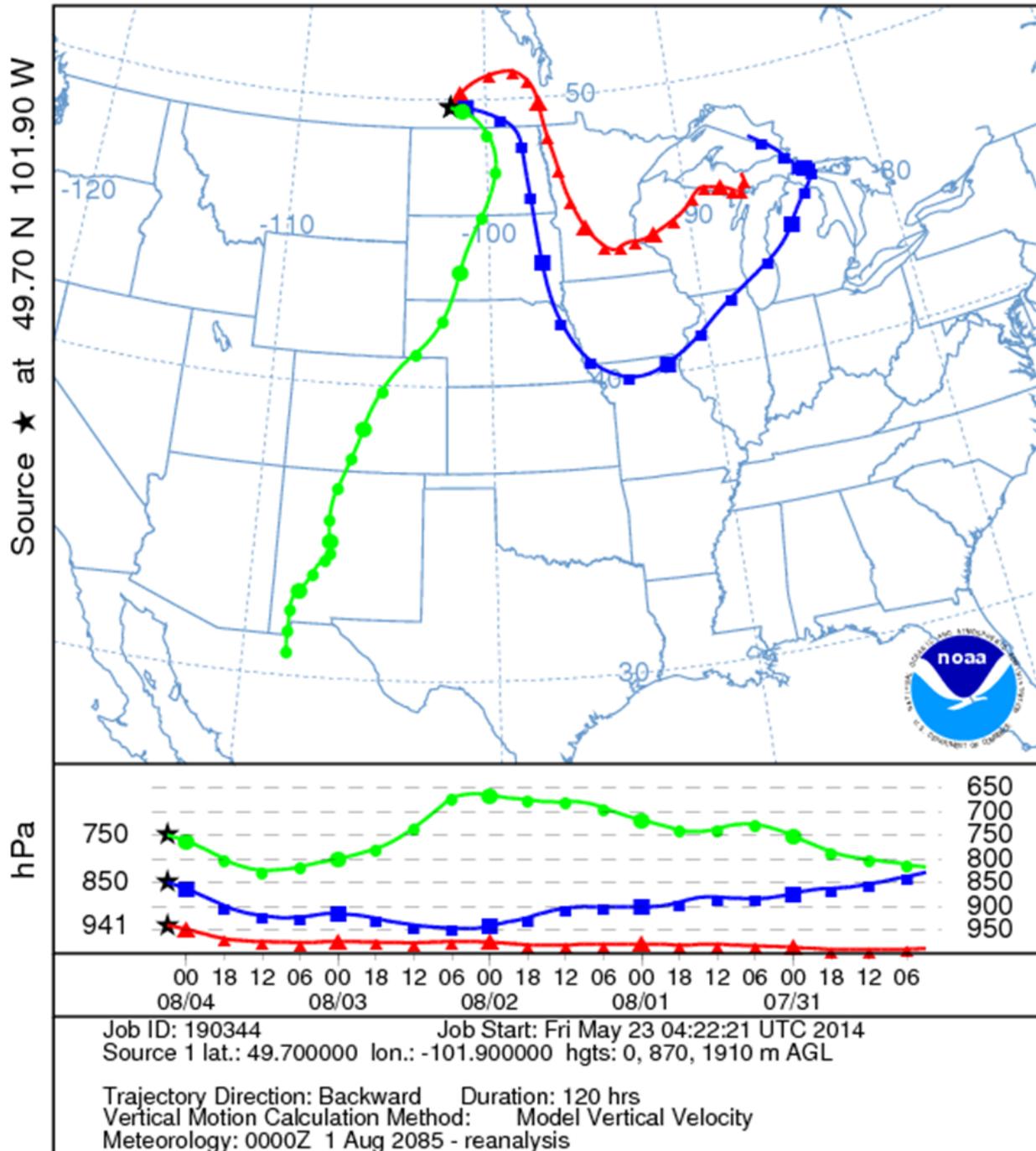
Precipitation (inches)		Stations
0.00 - 1.00	7.01 - 8.00	◆ Daily
1.01 - 2.00	8.01 - 9.00	■ Hourly
2.01 - 3.00	9.01 - 10.00	■ Hourly Estimated Pseudo
3.01 - 4.00	10.01 - 12.00	◆ Supplemental
4.01 - 5.00	12.01 - 14.00	◆ Supplemental Estimated
5.01 - 6.00	14.01 - 16.00	
6.01 - 7.00		



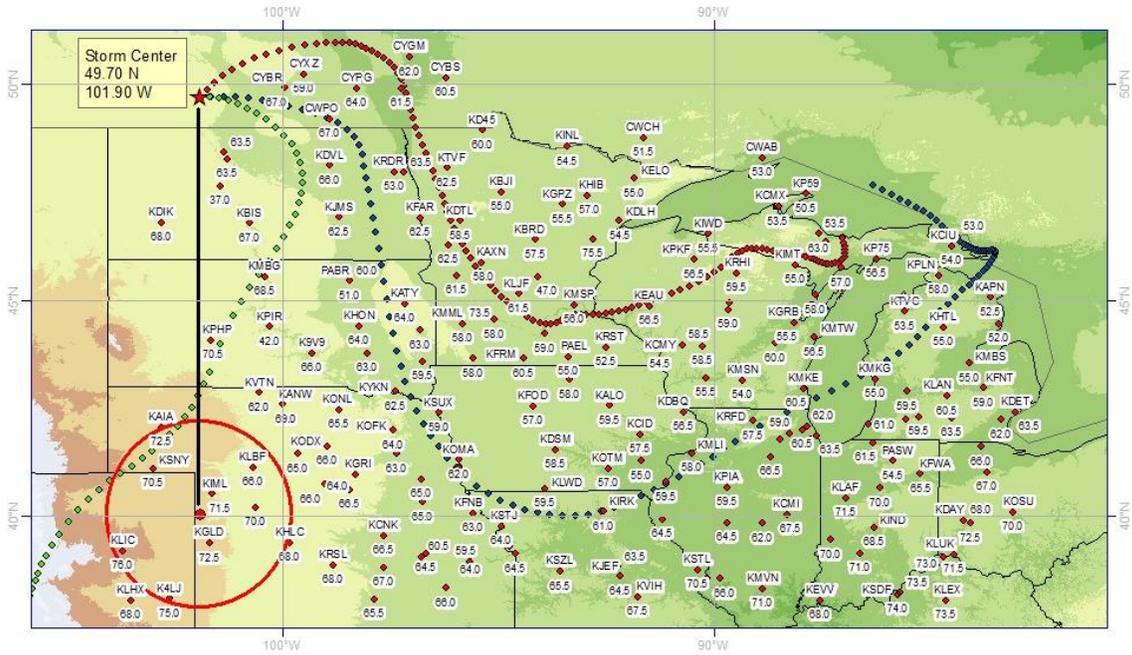
NOAA HYSPLIT MODEL

Backward trajectories ending at 0300 UTC 04 Aug 85

CDC1 Meteorological Data

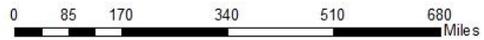


SPAS 1337 August 2 - 6, 1985



Hysplit

- ◆ Surface
- ◆ 850 mb
- ◆ 750 mb



Storm Precipitation Analysis System (SPAS) For Storm #1206_1 SPAS Analysis

General Storm Location: Central Michigan -- "Big Rapids '86" storm

Storm Dates: September 9-12, 1986

Event: Synoptic/Warm Front

DAD Zone 1

Latitude: 43.6125

Longitude: -85.3125

Max. Grid Rainfall Amount: 13.18 inches

Max. Observed Rainfall Amount: 13.13" at Big Rapids, MI

Number of Stations: 114 (66 Daily, 15 Hourly, 1 Hourly Estimated, 1 Hourly Estimated Pseudo, 4 Hourly Pseudo, 20 Supplemental, and 7 Supplemental Estimated)

SPAS Version: 8.5

Base Map Used: Mean (1971-2000) PRISM September Precipitation

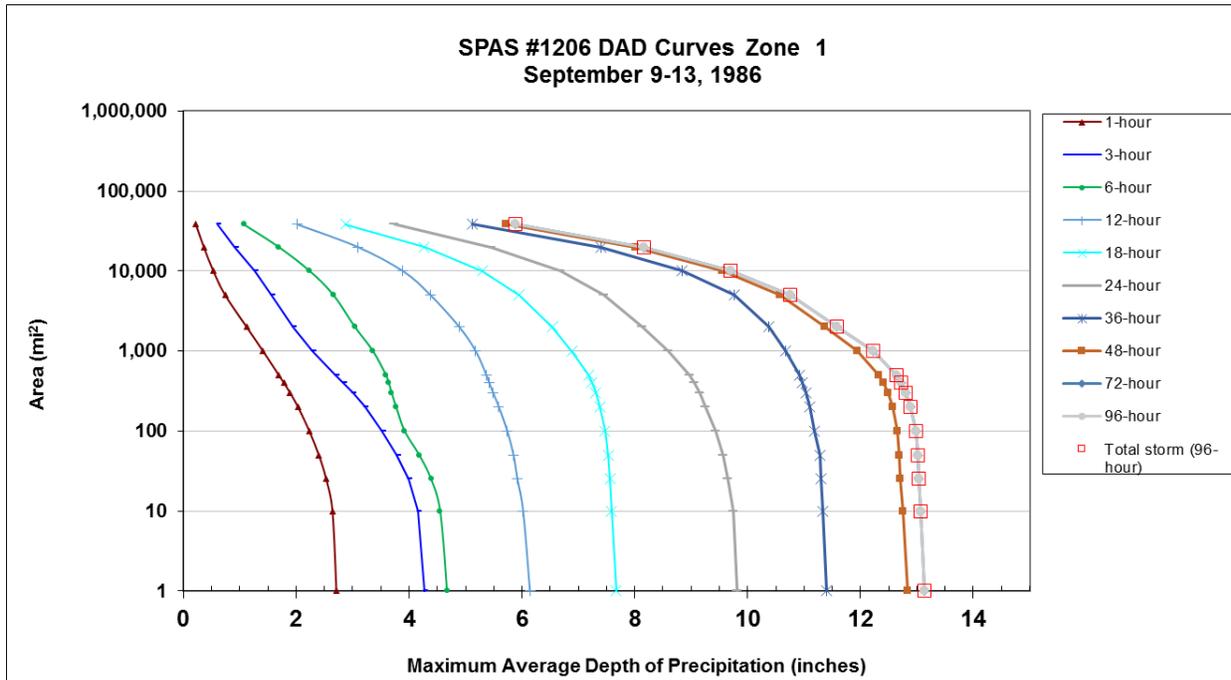
Spatial resolution: 30 seconds

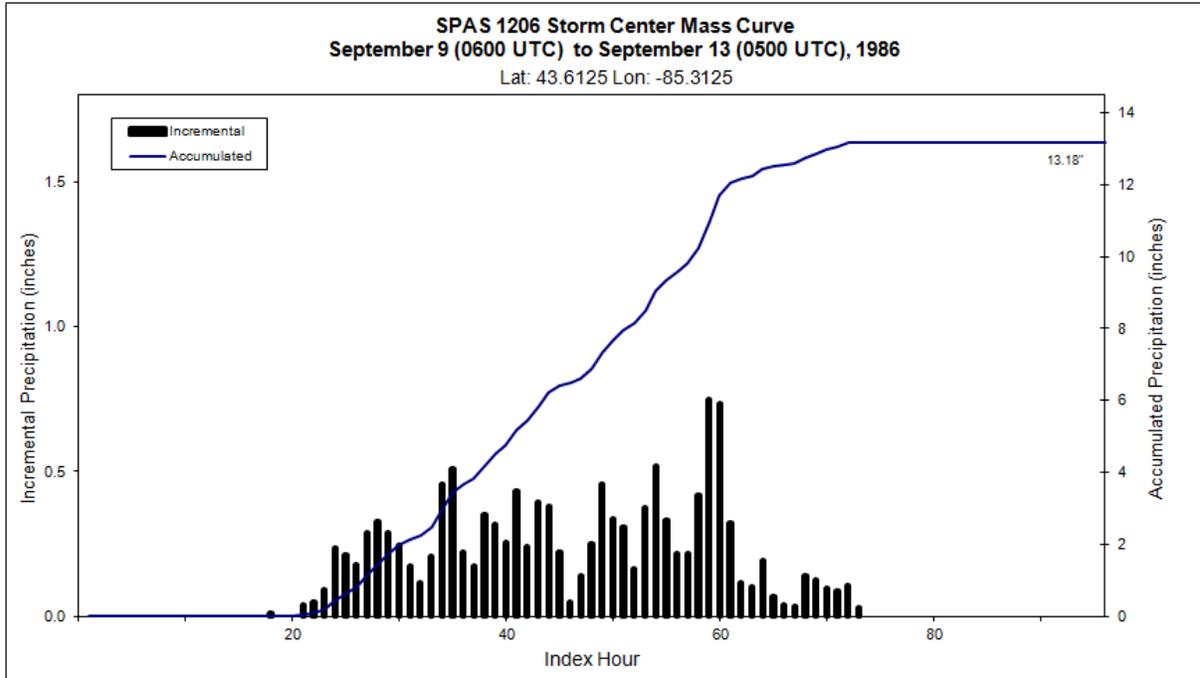
Radar Included: No

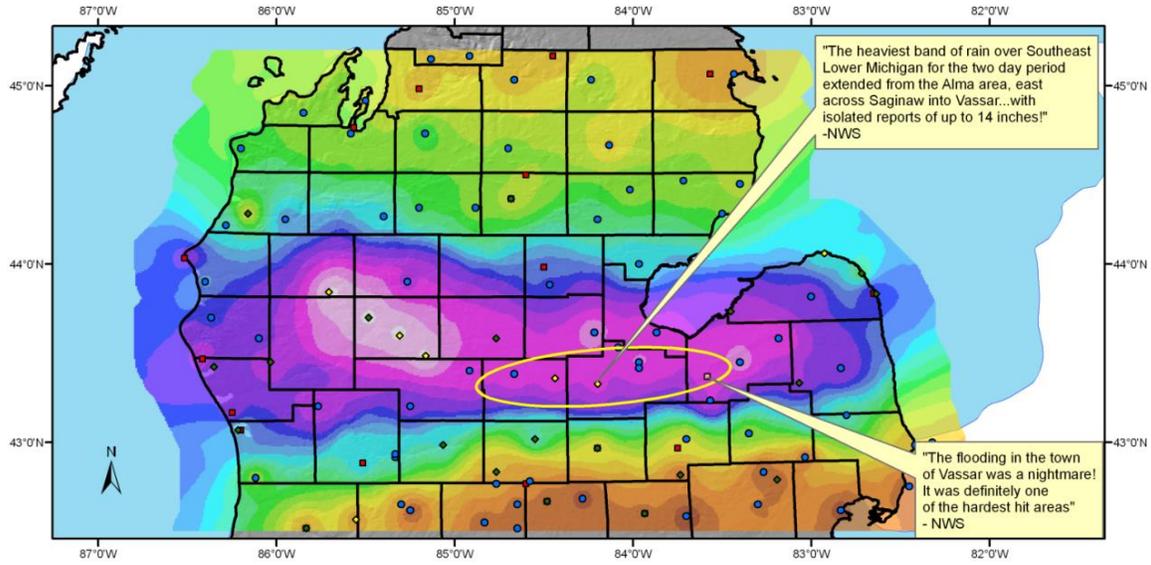
Depth-Area-Duration (DAD) analysis: Yes

Degree of confidence in results: This storm occurred during a period of limited data, so our confidence in these results is slightly less than normal due to limited rainfall reports and limited hourly data throughout the storm center. Several supplemental estimated stations were added based on inferences from old isohyetal maps (NWS and EPRI) and discussions/summaries of the storm. I feel good about our analysis given the great cooperation we had from the Detroit NWS and the information they provided. Further confidence was instilled into the results when we found the DAD results compared rather favorably to those computed in the EPRI study.

Storm 1206 - September 9 (0600 UTC) - September 13 (0500 UTC), 1986											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
Area (mi ²)	Duration (hours)										
	1	3	6	12	18	24	36	48	72	96	Total
0.4	2.72	4.28	4.68	6.17	7.68	9.84	11.42	12.86	13.17	13.17	13.17
1	2.71	4.27	4.67	6.14	7.67	9.81	11.40	12.83	13.13	13.13	13.13
10	2.64	4.15	4.55	6.02	7.59	9.74	11.33	12.75	13.06	13.06	13.06
25	2.53	3.99	4.39	5.92	7.56	9.65	11.30	12.71	13.03	13.03	13.03
50	2.40	3.78	4.18	5.85	7.53	9.57	11.28	12.69	13.01	13.01	13.01
100	2.23	3.52	3.92	5.74	7.47	9.43	11.19	12.66	12.98	12.98	12.98
200	2.03	3.21	3.77	5.59	7.38	9.26	11.10	12.57	12.89	12.89	12.89
300	1.89	3.00	3.69	5.49	7.31	9.16	11.03	12.49	12.81	12.81	12.81
400	1.78	2.83	3.64	5.42	7.24	9.06	10.97	12.40	12.72	12.72	12.72
500	1.69	2.69	3.59	5.37	7.18	8.97	10.92	12.33	12.64	12.64	12.64
1,000	1.41	2.29	3.36	5.18	6.89	8.59	10.68	11.94	12.22	12.22	12.22
2,000	1.12	1.94	3.04	4.89	6.54	8.13	10.37	11.36	11.58	11.58	11.58
5,000	0.74	1.56	2.66	4.38	5.95	7.45	9.76	10.57	10.75	10.75	10.75
10,000	0.53	1.26	2.24	3.89	5.30	6.68	8.84	9.55	9.70	9.70	9.70
20,000	0.36	0.91	1.69	3.09	4.27	5.45	7.40	8.01	8.16	8.16	8.16
38,327	0.22	0.60	1.07	2.02	2.87	3.73	5.13	5.72	5.88	5.88	5.88







"Big Rapids '86" ISOHYETAL FROM SPAS

Total 96-hour Rainfall (inches)
 09/09/1986 0600 UTC - 09/13/1986 0500 UTC
 SPAS #1206

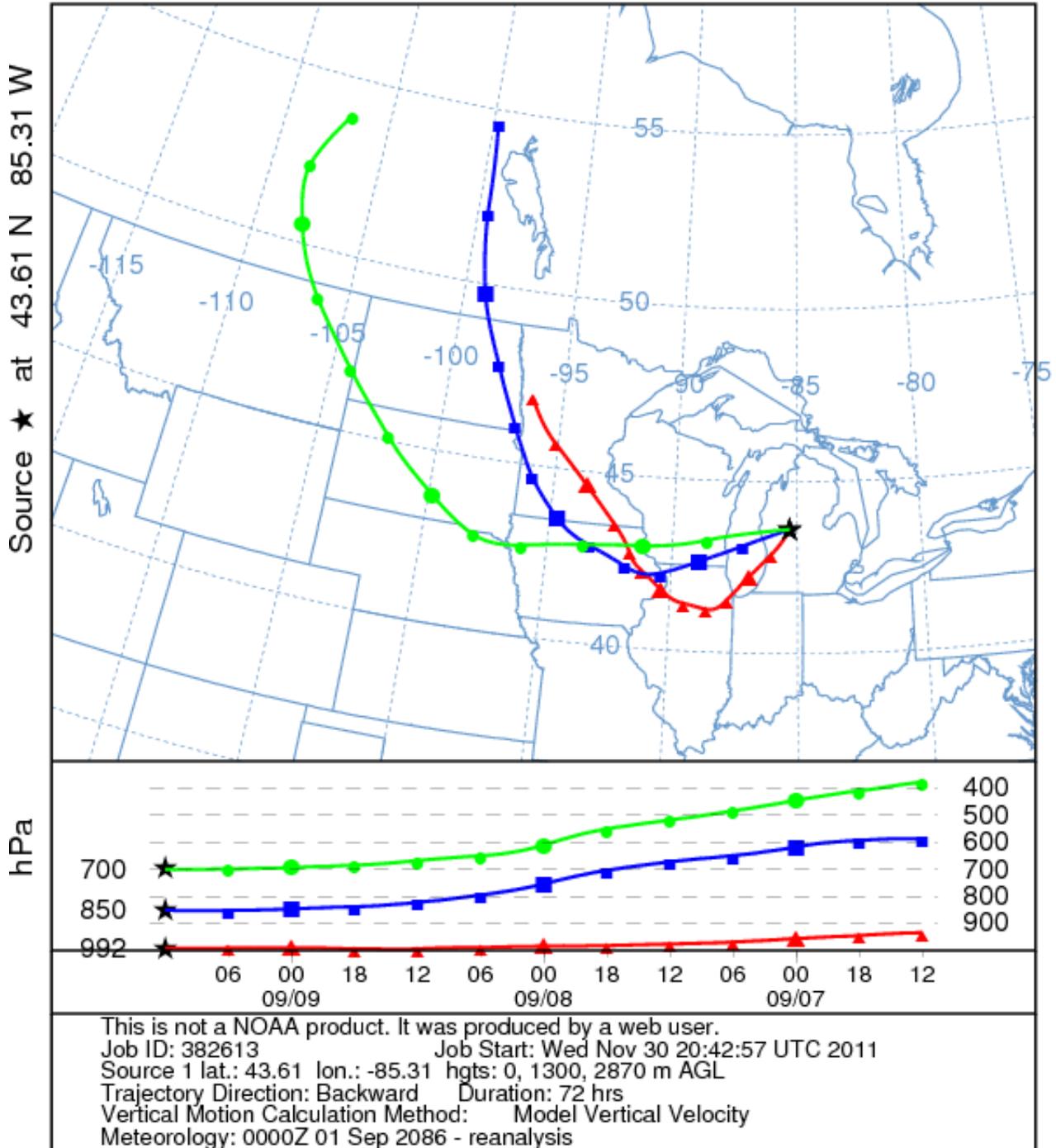
Legend

- | | | | | | |
|-------------|-------------|--------------|---------------|----------------------|---------------------|
| 0.00 - 0.50 | 3.01 - 3.50 | 6.01 - 6.50 | 10.01 - 11.00 | • Daily | ■ Hourly Pseudo |
| 0.51 - 1.00 | 3.51 - 4.00 | 6.51 - 7.00 | 11.01 - 12.00 | ■ Hourly | ◆ Supplemental |
| 1.01 - 1.50 | 4.01 - 4.50 | 7.01 - 7.50 | 12.01 - 13.00 | □ Hourly Estimated | ◆ Supplemental Est. |
| 1.51 - 2.00 | 4.51 - 5.00 | 7.51 - 8.00 | 13.01 - 14.00 | ■ Hourly Est. Pseudo | |
| 2.01 - 2.50 | 5.01 - 5.50 | 8.01 - 9.00 | | | |
| 2.51 - 3.00 | 5.51 - 6.00 | 9.01 - 10.00 | | | |

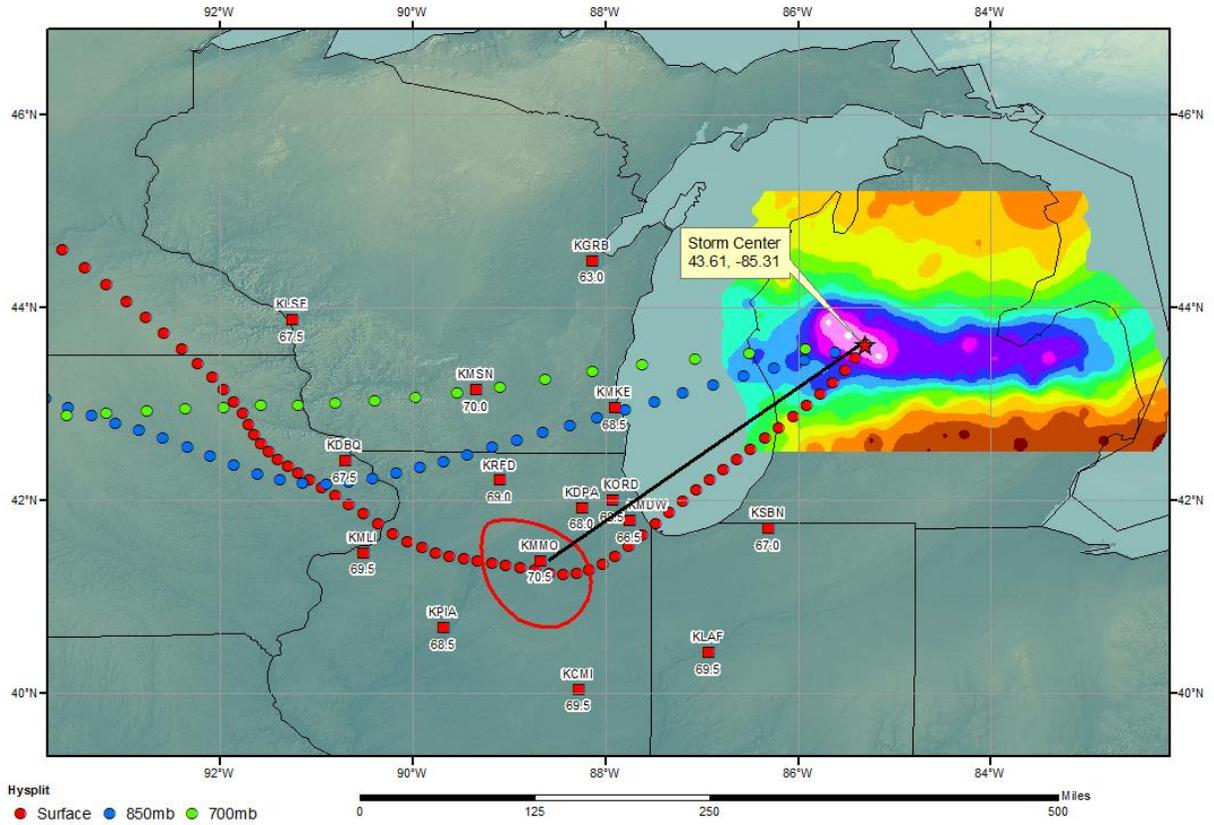


METSTAT
 04/22/2011

NOAA HYSPLIT MODEL Backward trajectories ending at 1200 UTC 09 Sep 86 CDC1 Meteorological Data



SPAS 1206 Big Rapids, MI Storm Analysis September 9-13 1986



Storm Precipitation Analysis System (SPAS) For Storm #1735_1 SPAS Analysis

General Storm Location: Coldwater, MI

Storm Dates: May 29 – June 3, 1989

Event: Synoptic/Warm Front

DAD Zone 1

Latitude: 41.9625

Longitude: - 85.0042

Max. Grid Rainfall Amount: 9.20"

Max. Observed Rainfall Amount: 9.10"

Number of Stations: 935

SPAS Version: 10.0

Base Map Used: PRISM climatology from May 1989

Spatial resolution: 0.2420

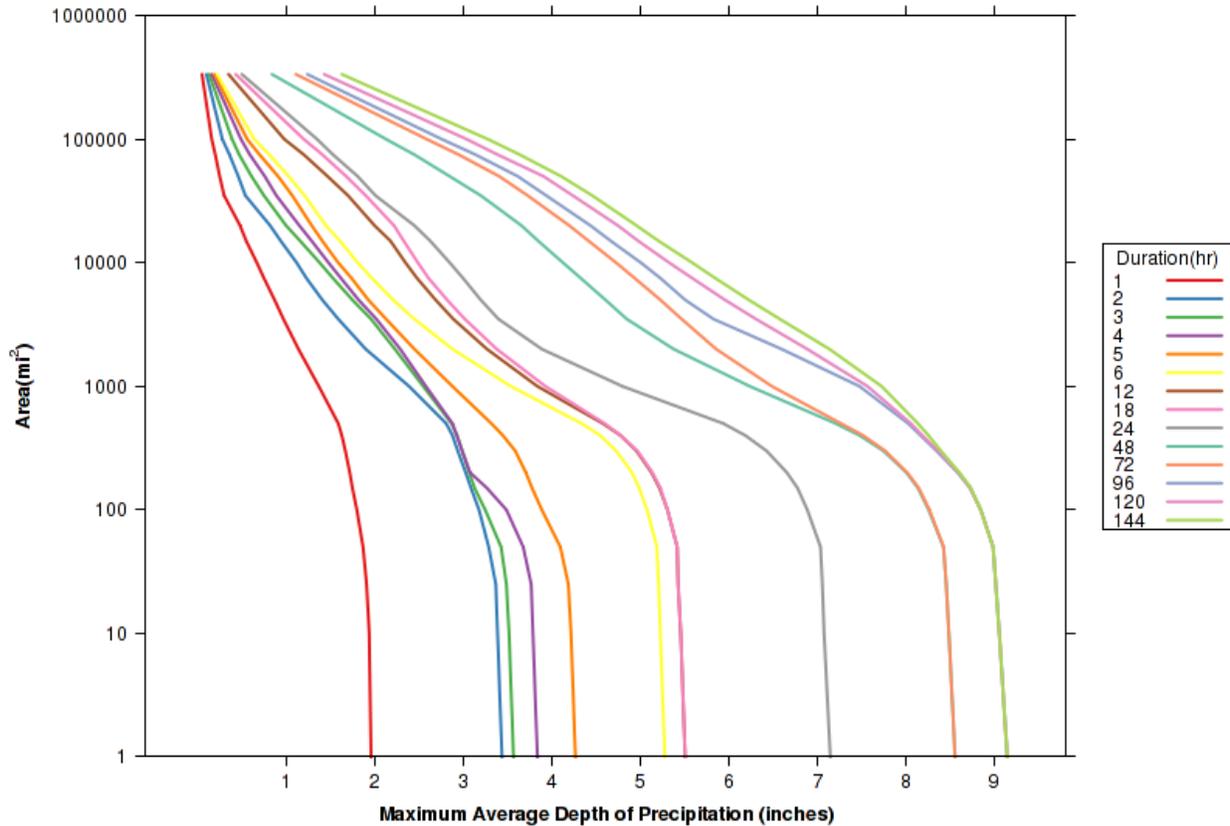
Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes

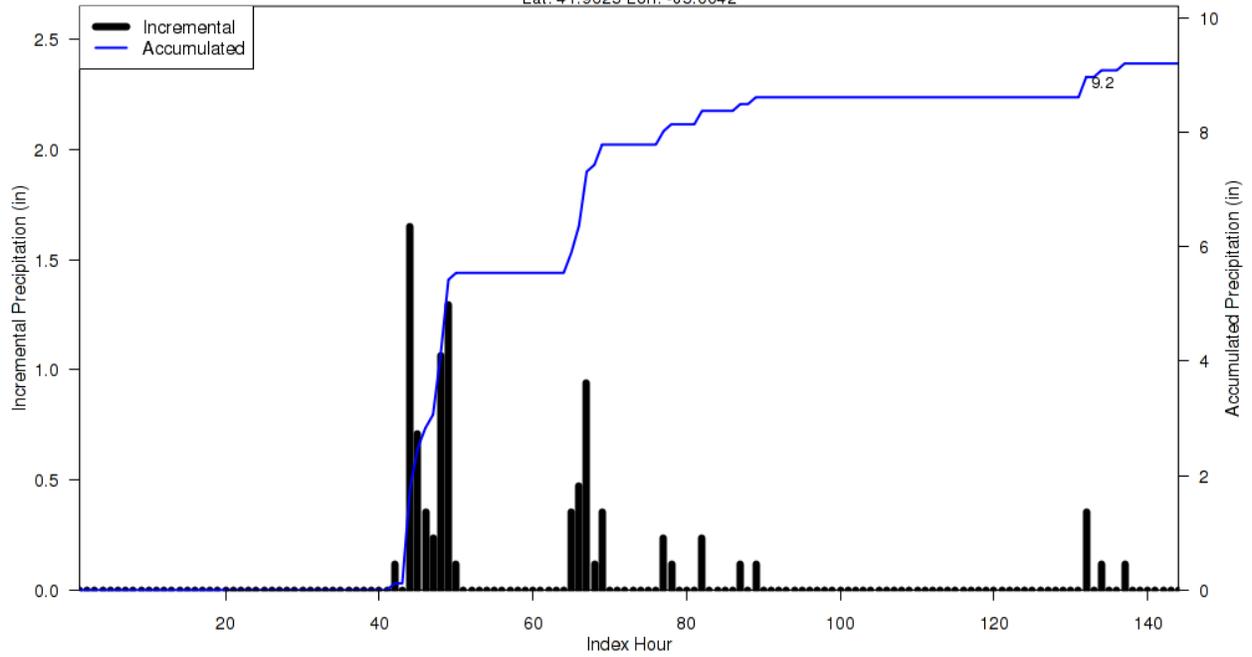
Degree of confidence in results: This analysis was based on 935 hourly stations, daily data, and supplemental station data. We have a good degree of confidence for the station based storm total results. The spatial pattern is fully dependent on the PRISM basemap. Timing is based on the hourly and hourly pseudo stations. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

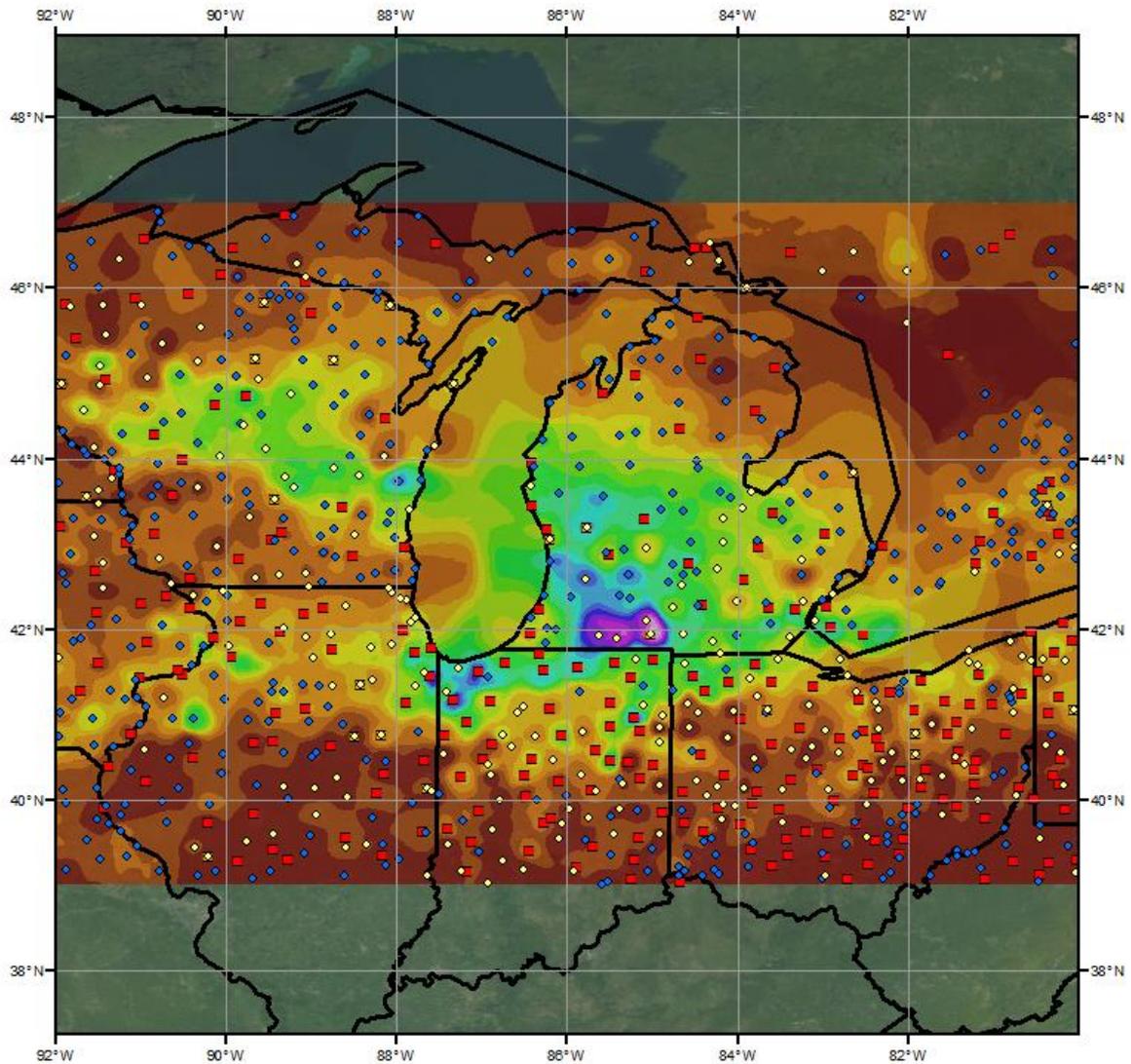
SPAS 1735 - May 29 (0700 UTC) - June 4 (0600 UTC), 1989										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	6	12	24	48	72	96	120	144	Total
0.4	1.96	5.30	5.53	7.18	8.59	8.59	9.18	9.18	9.18	9.18
1	1.96	5.28	5.51	7.15	8.56	8.56	9.15	9.15	9.15	9.15
10	1.94	5.23	5.46	7.08	8.49	8.49	9.06	9.06	9.06	9.06
25	1.91	5.21	5.43	7.06	8.46	8.46	9.02	9.02	9.02	9.02
50	1.87	5.19	5.42	7.04	8.43	8.43	8.99	8.99	8.99	8.99
100	1.80	5.08	5.31	6.89	8.26	8.27	8.85	8.85	8.85	8.85
200	1.72	4.91	5.13	6.66	8.01	8.02	8.59	8.60	8.61	8.61
300	1.67	4.73	4.96	6.43	7.75	7.77	8.35	8.37	8.40	8.40
400	1.63	4.55	4.78	6.19	7.48	7.52	8.17	8.19	8.26	8.26
500	1.59	4.34	4.58	5.94	7.21	7.27	8.03	8.06	8.14	8.14
1,000	1.37	3.54	3.84	4.80	6.24	6.49	7.48	7.57	7.73	7.73
2,000	1.14	2.88	3.27	3.89	5.38	5.86	6.60	6.89	7.14	7.14
5,000	0.87	2.21	2.69	3.20	4.61	5.23	5.51	5.96	6.23	6.23
10,000	0.67	1.81	2.35	2.85	4.13	4.73	5.01	5.33	5.59	5.59
20,000	0.48	1.45	2.00	2.45	3.66	4.20	4.44	4.75	4.96	4.96
50,000	0.25	1.03	1.47	1.81	2.85	3.41	3.62	3.91	4.11	4.11
100,000	0.16	0.64	0.98	1.35	2.13	2.59	2.76	3.04	3.28	3.28
335,486	0.05	0.22	0.35	0.50	0.84	1.11	1.24	1.43	1.63	1.63

SPAS 1735 DAD Curves Zone 1
May 29 (0700UTC) to June 4 (0600UTC), 1989



SPAS 1735 Storm Center Mass Curve Zone 1
May 29 (0700UTC) to June 4 (0600UTC), 1989
Lat: 41.9625 Lon: -85.0042

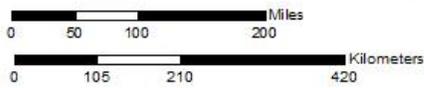




Total Storm (144-hours) Precipitation (inches)
May 29 - June 3, 1989
SPAS 1735 - Coldwater, MI

Gauges

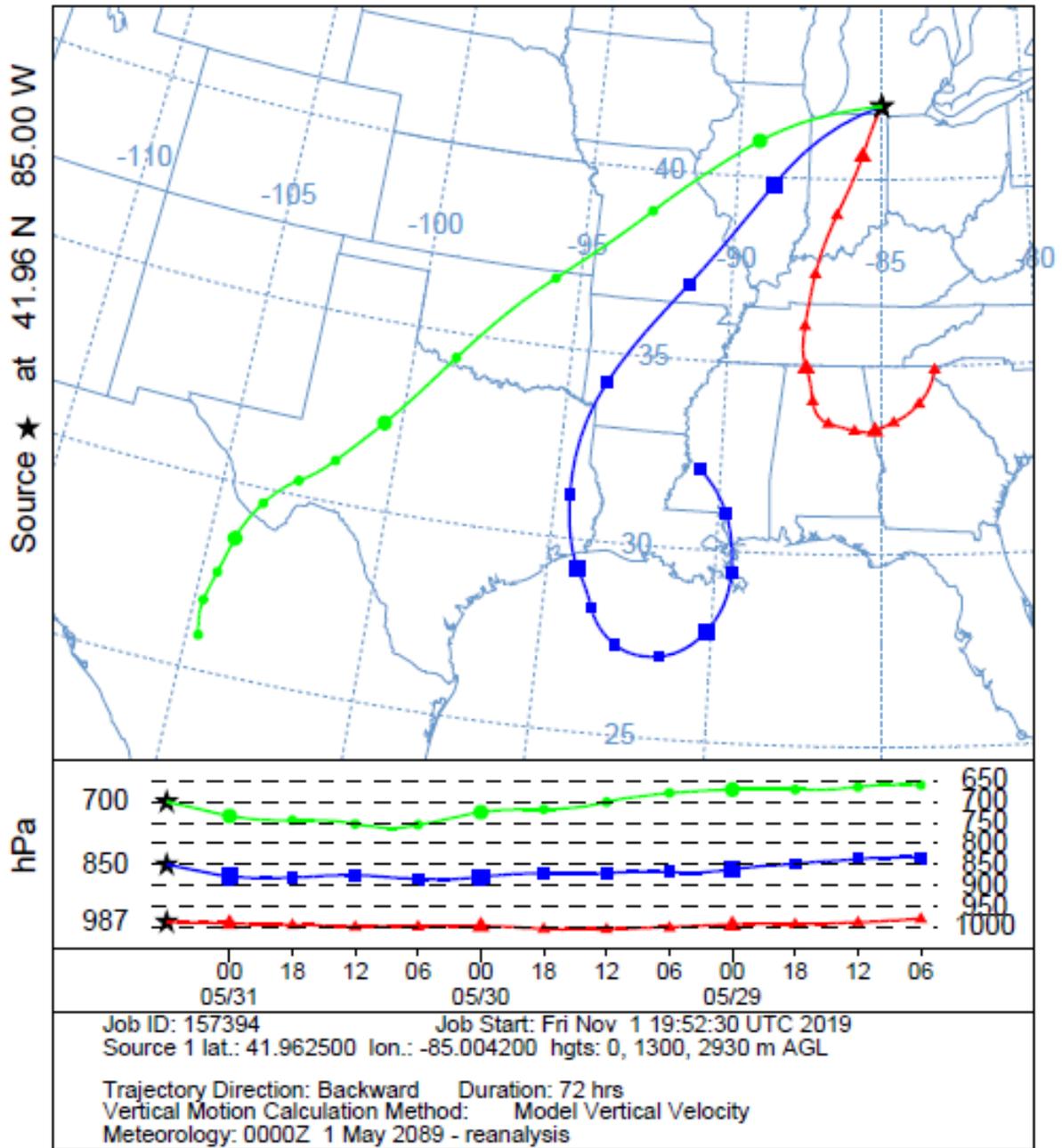
- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental



Precipitation (inches)		
0.00 - 0.50	2.01 - 2.50	4.51 - 5.00
0.51 - 1.00	2.51 - 3.00	5.01 - 5.50
1.01 - 1.50	3.01 - 3.50	5.51 - 6.00
1.51 - 2.00	3.51 - 4.00	6.01 - 6.50
	4.01 - 4.50	6.51 - 7.00
		7.01 - 7.50
		7.51 - 8.00
		8.01 - 8.50
		8.51 - 9.00
		9.01 - 9.50



NOAA HYSPLIT MODEL
 Backward trajectories ending at 0600 UTC 31 May 89
 CDC1 Meteorological Data



Storm Precipitation Analysis System (SPAS) For Storm #1297_1 SPAS-NEXRAD Analysis

General Storm Location: Roseau, Minnesota

Storm Dates: June 9-11, 2002

Event: MCC

DAD Zone 1

Latitude: 48.875

Longitude: -95.085

Max. Grid Rainfall Amount: 14.62"

Max. Observed Rainfall Amount: 14.55"

Number of Stations: 726 (2007 Daily, 50 Hourly, 32 Hourly Pseudo, and 437 Supplemental)

SPAS Version: 9.5

Basemap: PRISM 30-yr Mean (1981-2010) June Precipitation and Total Radar Reflectivity

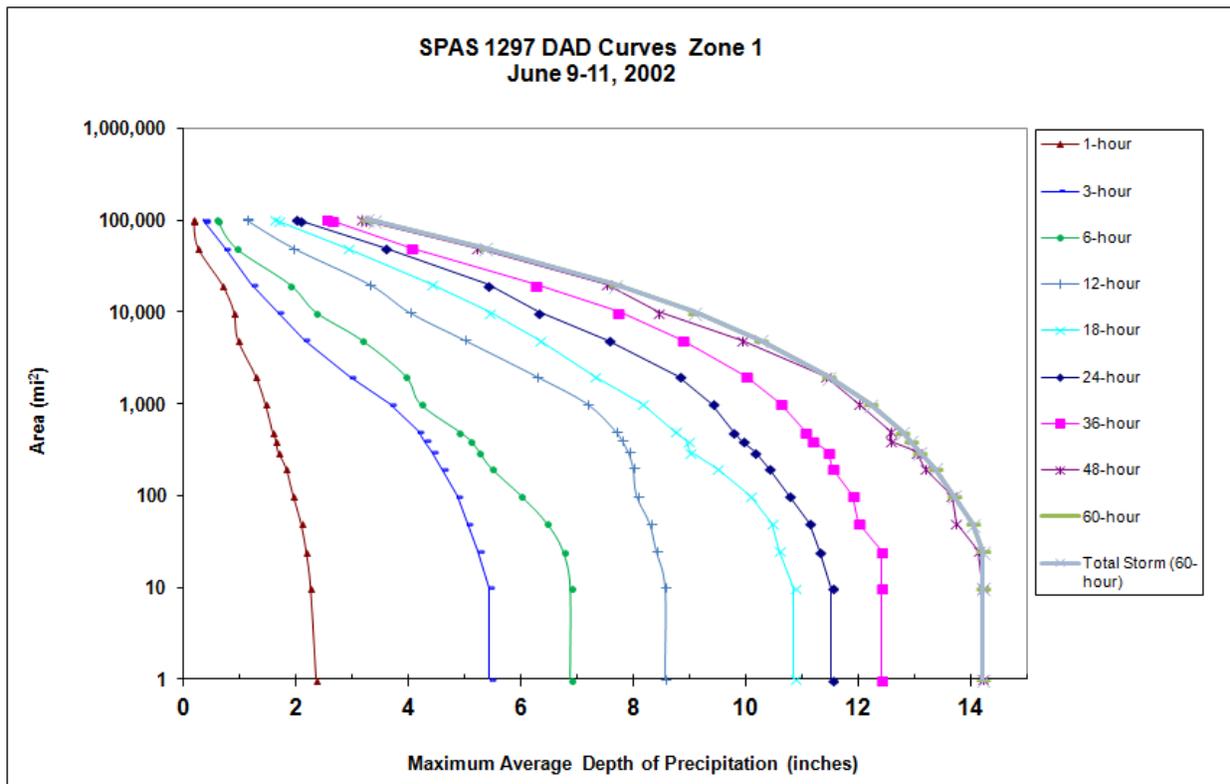
Spatial resolution: 0.01 (~ 0.30 mi²)

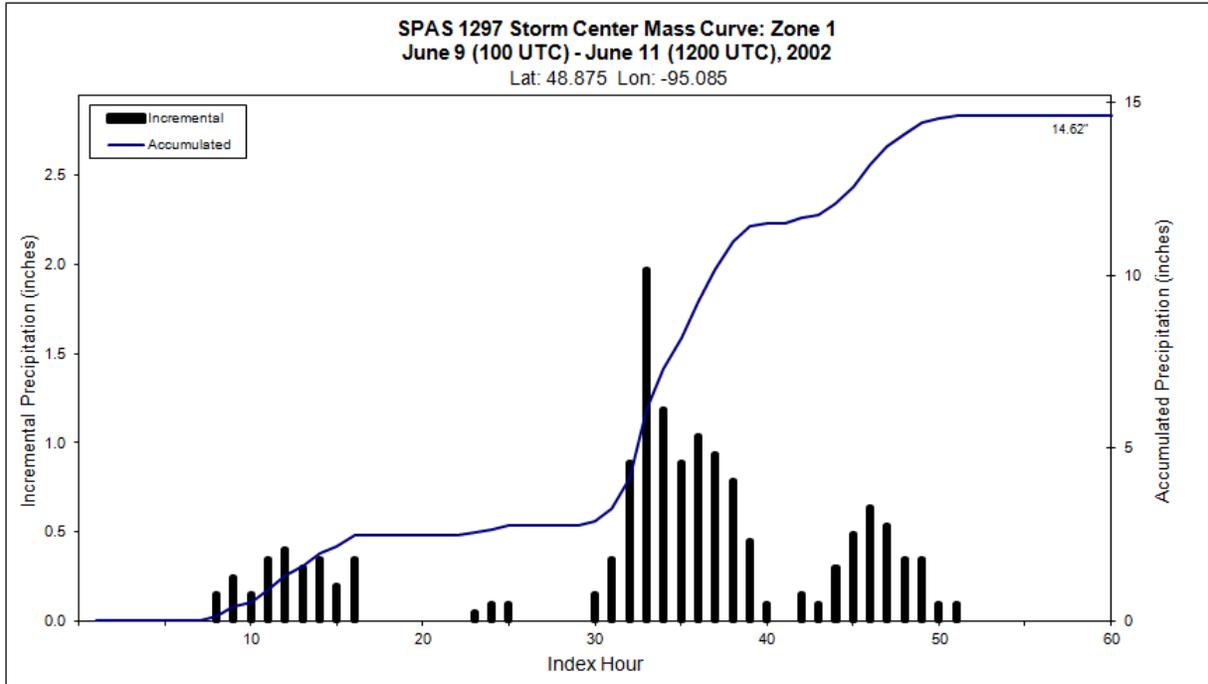
Radar Included: Yes

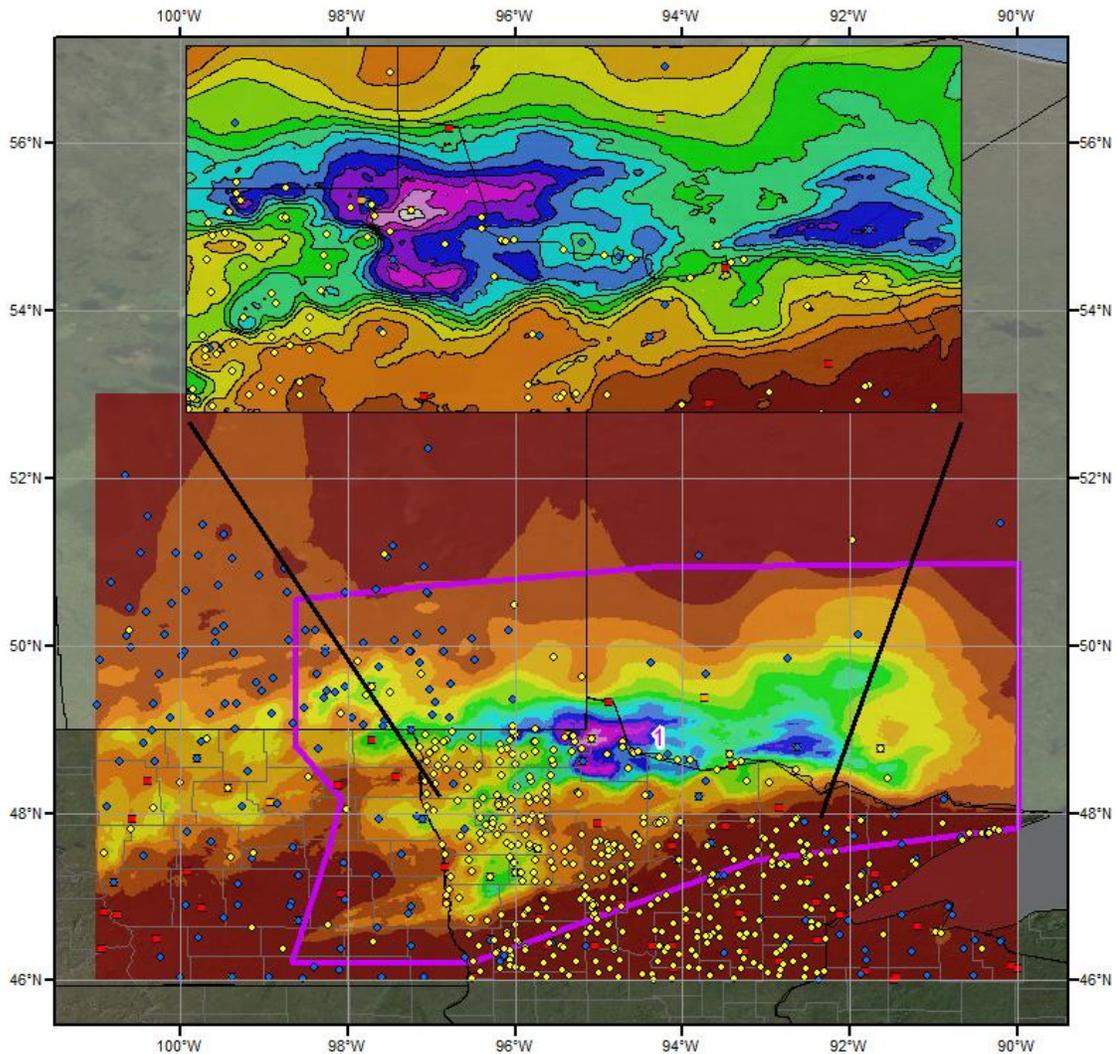
Depth-Area-Duration (DAD) analysis: Yes

Reliability of results: This analysis was based on hourly data, daily data, supplemental station data and NEXRAD Radar. We have a high degree of confidence in the radar/station based storm total results, the spatial pattern is dependent on the radar data and basemap, and the timing is based on hourly and hourly pseudo stations.

Storm 1297 - June 9 (100 UTC) - June 11 (1200 UTC), 2002										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	3	6	12	18	24	36	48	60	Total
0.3	2.42	5.6	7.11	8.81	11.18	11.88	12.83	14.62	14.62	14.62
1	2.37	5.45	6.89	8.57	10.86	11.52	12.41	14.22	14.22	14.22
10	2.27	5.43	6.89	8.57	10.86	11.52	12.41	14.22	14.22	14.22
25	2.19	5.24	6.76	8.41	10.6	11.3	12.41	14.14	14.21	14.21
50	2.1	5.05	6.47	8.29	10.46	11.13	12.01	13.74	14.03	14.03
100	1.96	4.87	6.01	8.06	10.08	10.76	11.91	13.66	13.69	13.69
200	1.83	4.6	5.48	8	9.48	10.41	11.54	13.18	13.37	13.37
300	1.69	4.42	5.27	7.91	8.99	10.15	11.46	13.04	13.08	13.08
400	1.65	4.29	5.11	7.8	8.96	9.93	11.19	12.58	12.92	12.92
500	1.59	4.17	4.91	7.69	8.73	9.76	11.05	12.57	12.77	12.77
1,000	1.46	3.68	4.22	7.18	8.15	9.4	10.62	12.01	12.2	12.20
2,000	1.29	2.96	3.96	6.27	7.3	8.8	10	11.42	11.47	11.47
5,000	0.97	2.15	3.17	4.98	6.34	7.55	8.88	9.92	10.26	10.26
10,000	0.9	1.67	2.36	4.01	5.44	6.3	7.74	8.45	9.09	9.09
20,000	0.69	1.21	1.9	3.31	4.4	5.4	6.27	7.51	7.66	7.66
50,000	0.26	0.74	0.94	1.95	2.91	3.58	4.06	5.21	5.36	5.36
100,000	0.18	0.37	0.61	1.13	1.68	2.07	2.65	3.24	3.39	3.39
103,535	0.18	0.37	0.59	1.12	1.62	2	2.56	3.17	3.27	3.27







Total Storm (60-hr) Precipitation (inches)
6/9/2002 (0100 UTC) - 6/11/2002 (1200 UTC)
SPAS-NEXRAD 1297

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental



Precipitation (inches)

0.00 - 1.00	3.01 - 4.00	6.01 - 7.00	9.01 - 10.00	12.01 - 13.00
1.01 - 2.00	4.01 - 5.00	7.01 - 8.00	10.01 - 11.00	13.01 - 14.00
2.01 - 3.00	5.01 - 6.00	8.01 - 9.00	11.01 - 12.00	14.01 - 15.00

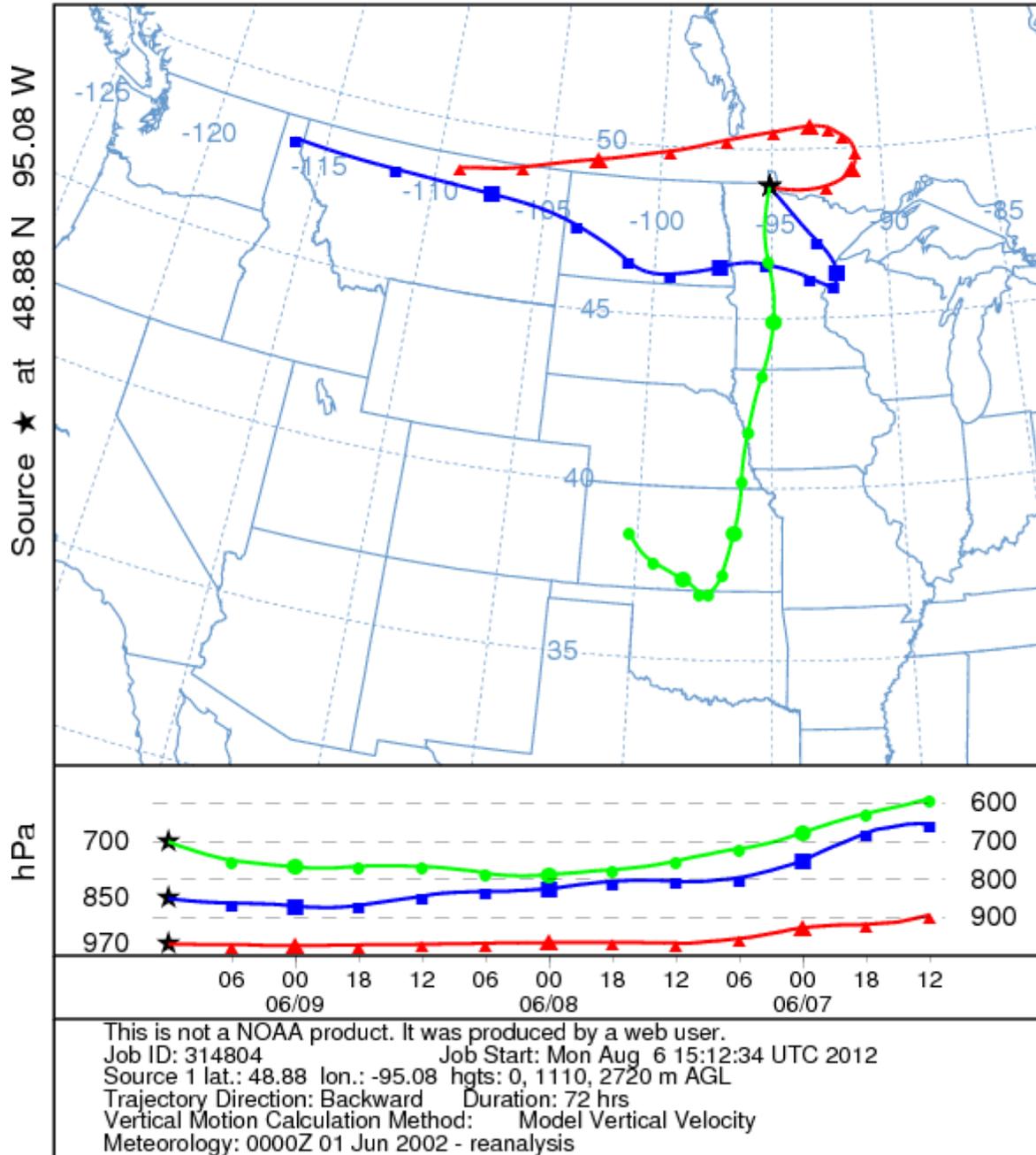


9/28/2012

NOAA HYSPLIT MODEL

Backward trajectories ending at 1200 UTC 09 Jun 02

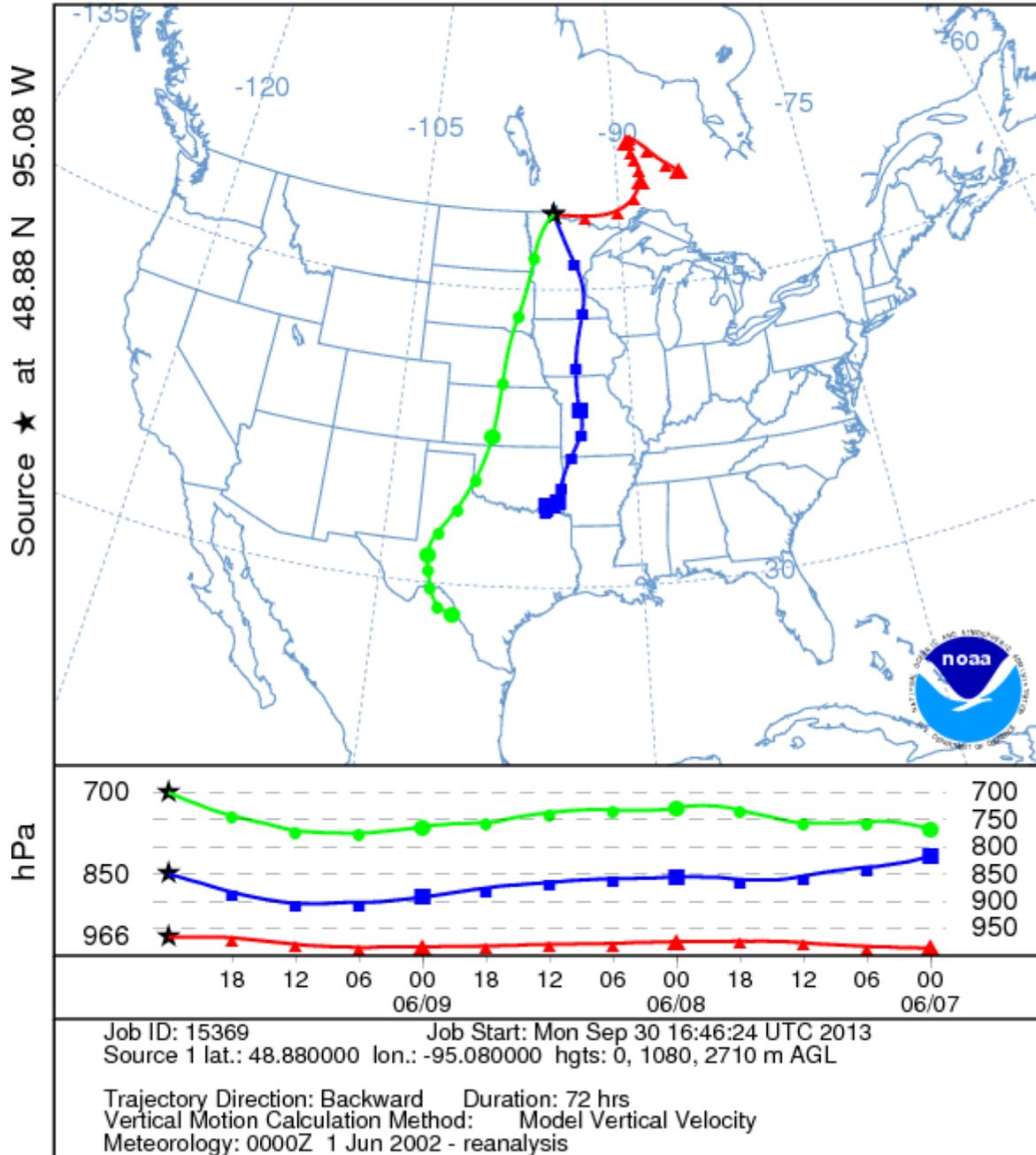
CDC1 Meteorological Data



NOAA HYSPLIT MODEL

Backward trajectories ending at 0000 UTC 10 Jun 02

CDC1 Meteorological Data



Storm Precipitation Analysis System (SPAS) For Storm #1048_1 SPAS-NEXRAD Analysis

General Storm Location: Hokah, MN

Storm Dates: 8/18/2007 0600Z – 8/21/2007 1000Z

Event: Cloudburst Thunderstorm

DAD Zone 1

Latitude: 43.81251

Longitude: -91.3625

Max. Grid/Radar Rainfall Amount: 18.26" (Grid/Pixel Point)

Max. Observed Rainfall Amount: 18.32" (grid cell 18.26" at HIDEN519) ***elevated 18.32" to 18.93" (0.026" for 24-hr period), this was done to achieve the state record 24-hr rainfall (17.21"). Smoothing of the data reduced the observed max below 17.00"****

Number of Stations: 886 (99-hourly, 1 hourly pseudo, 574-daily, 212-daily supplemental) gauging stations within the defined search domain.

SPAS Version: 5.0

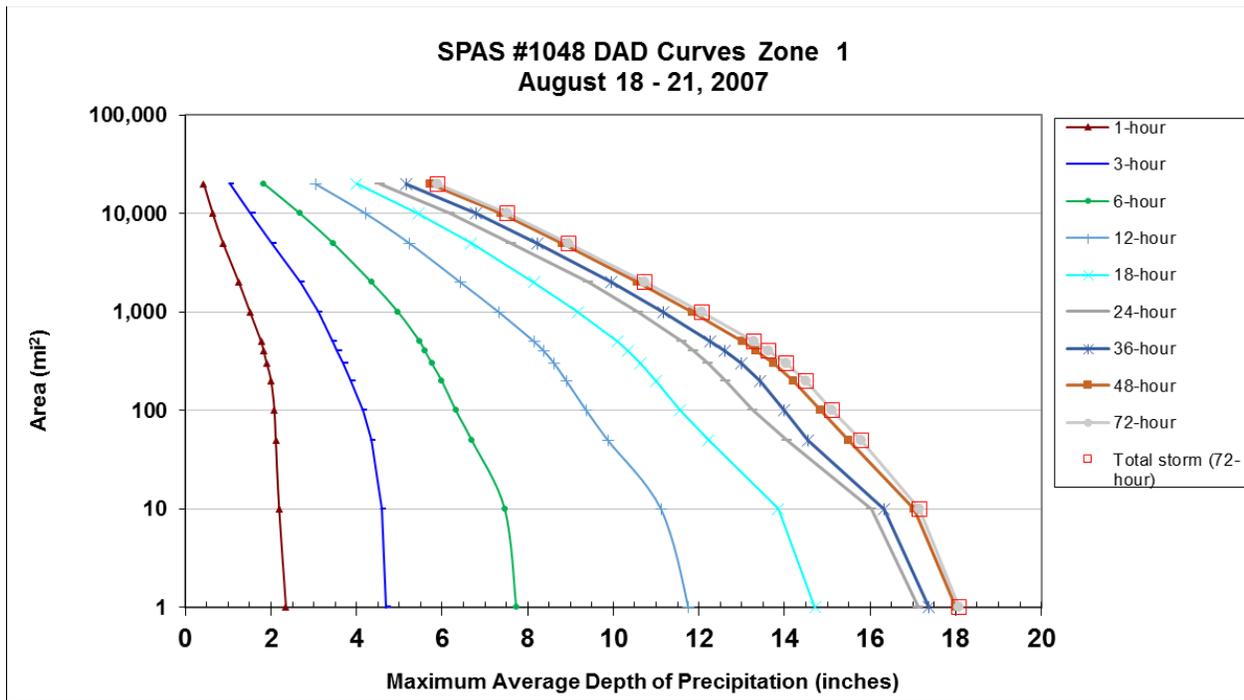
Base Map Used: No

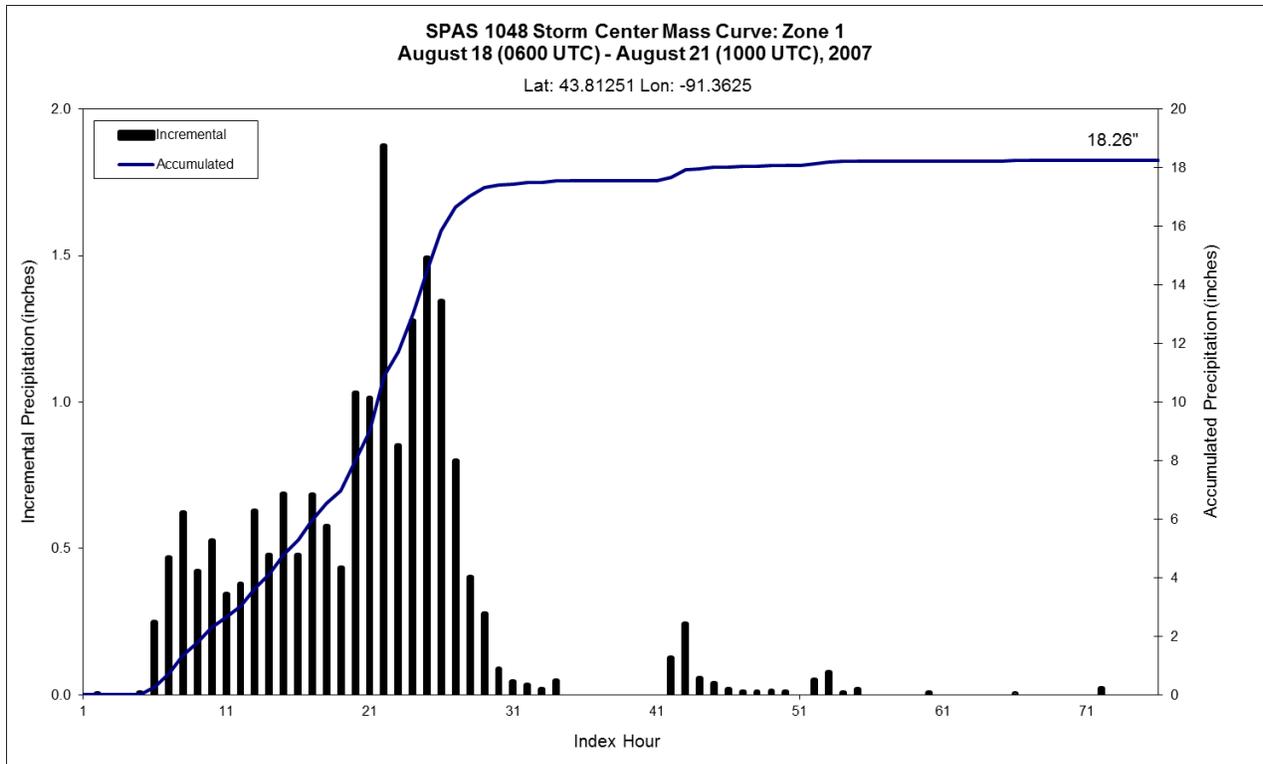
Spatial resolution: 0.24 mi²

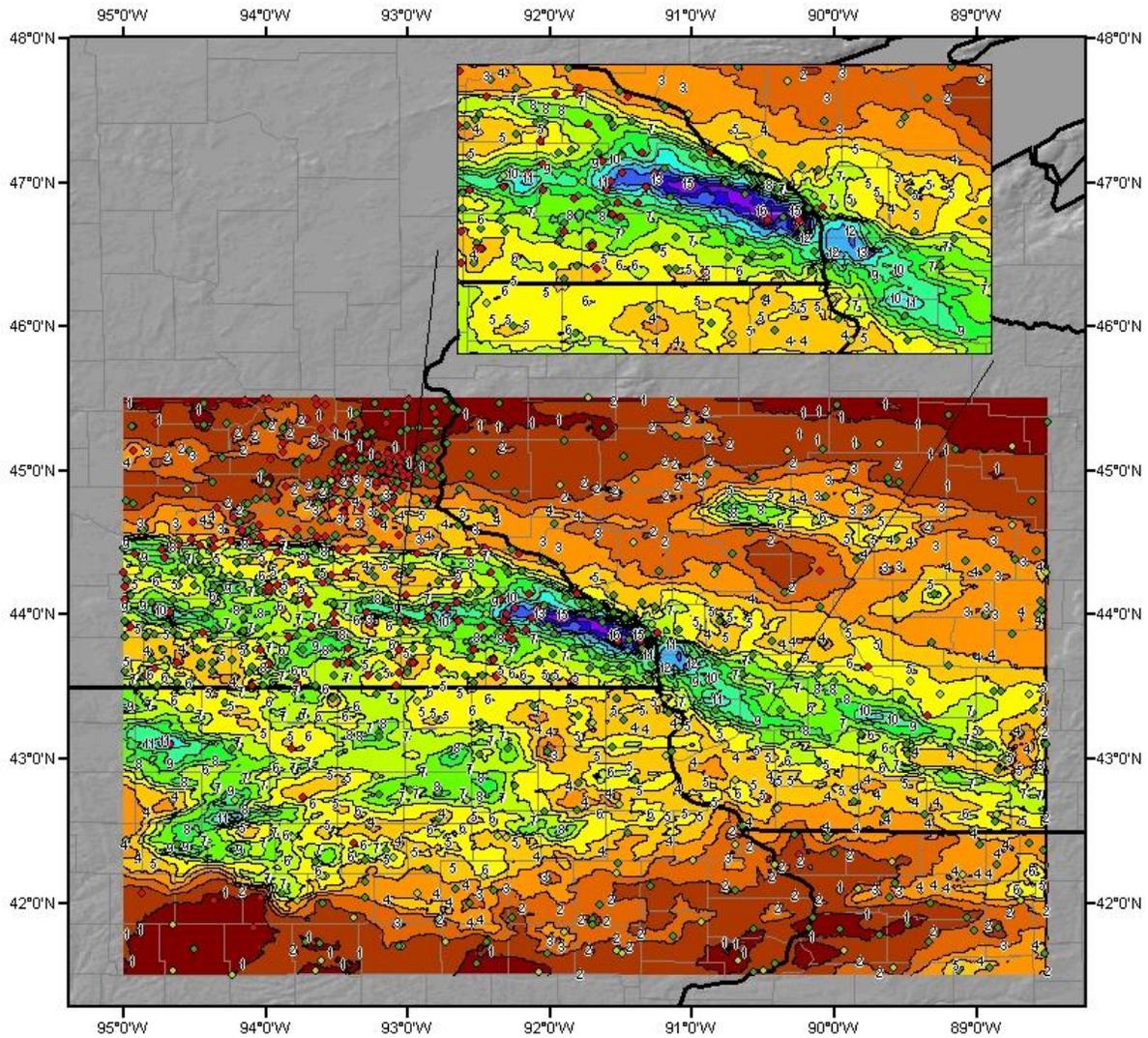
Radar Included: Yes, Weather Decision Technologies (WDT) Level-II radar reflectivity data based on Minneapolis/St. Paul, MN (KMPX), La Crosse, WI (KARX), Des Moines, IA (KDMX), and Milwaukee, WI (KMKX) NEXRAD.

Depth-Area-Duration (DAD) analysis: Yes: 1, 3, 6, 12, 18, 24, 36, 48, 72, & 76 hours

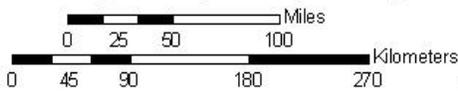
Storm 1048 - August 18 (0600 UTC) - August 21 (1000 UTC), 2007										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	3	6	12	18	24	36	48	72	Total
0.4	2.42	4.74	7.81	11.84	14.82	17.24	17.48	18.13	18.19	18.19
1	2.35	4.69	7.73	11.75	14.71	17.12	17.36	18.01	18.08	18.08
10	2.19	4.58	7.46	11.11	13.85	16.04	16.33	17.03	17.14	17.14
50	2.11	4.34	6.69	9.87	12.22	14.07	14.56	15.49	15.78	15.78
100	2.08	4.14	6.32	9.37	11.57	13.27	13.99	14.83	15.12	15.12
200	2.00	3.87	5.99	8.90	10.99	12.62	13.43	14.22	14.50	14.50
300	1.90	3.69	5.76	8.62	10.64	12.21	13.00	13.74	14.03	14.03
400	1.83	3.55	5.60	8.38	10.35	11.88	12.61	13.34	13.63	13.63
500	1.77	3.44	5.48	8.15	10.11	11.61	12.27	13.01	13.28	13.28
1000	1.51	3.10	4.97	7.32	9.17	10.59	11.17	11.84	12.06	12.06
2,000	1.25	2.69	4.35	6.43	8.15	9.41	9.96	10.57	10.74	10.74
5,000	0.88	2.02	3.45	5.23	6.67	7.63	8.23	8.80	8.95	8.95
10,000	0.64	1.53	2.68	4.21	5.45	6.18	6.78	7.37	7.53	7.53
20,000	0.43	1.03	1.84	3.04	4.00	4.55	5.15	5.71	5.88	5.88







**Total Rainfall (76-hours)
Hokah, MN 2007 Storm
Storm #1048 August 18 (0600 Z) to 21 (1000 Z), 2007**

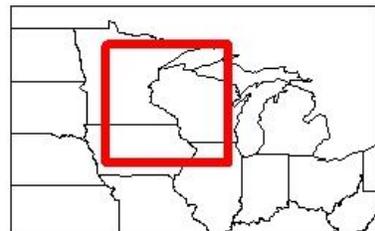


Gauging Stations

- ◆ Daily
- ◆ Hourly
- ◆ Hourly Pseudo
- ◆ Supplemental

Precipitation (inches)

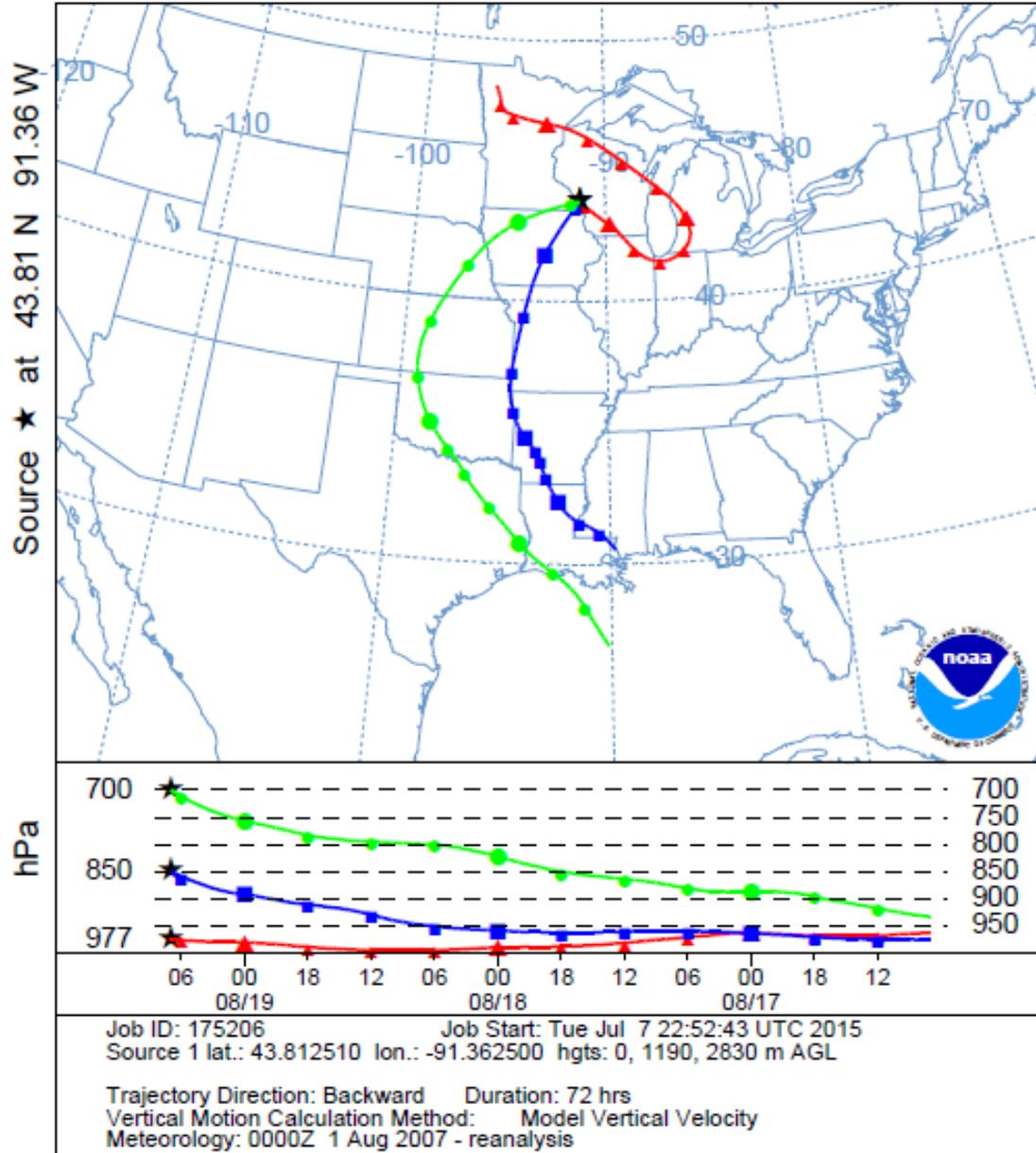
0.00 - 1.00	5.01 - 6.00	10.01 - 11.00	15.01 - 16.00
1.01 - 2.00	6.01 - 7.00	11.01 - 12.00	16.01 - 17.00
2.01 - 3.00	7.01 - 8.00	12.01 - 13.00	17.01 - 18.00
3.01 - 4.00	8.01 - 9.00	13.01 - 14.00	18.01 - 19.00
4.01 - 5.00	9.01 - 10.00	14.01 - 15.00	



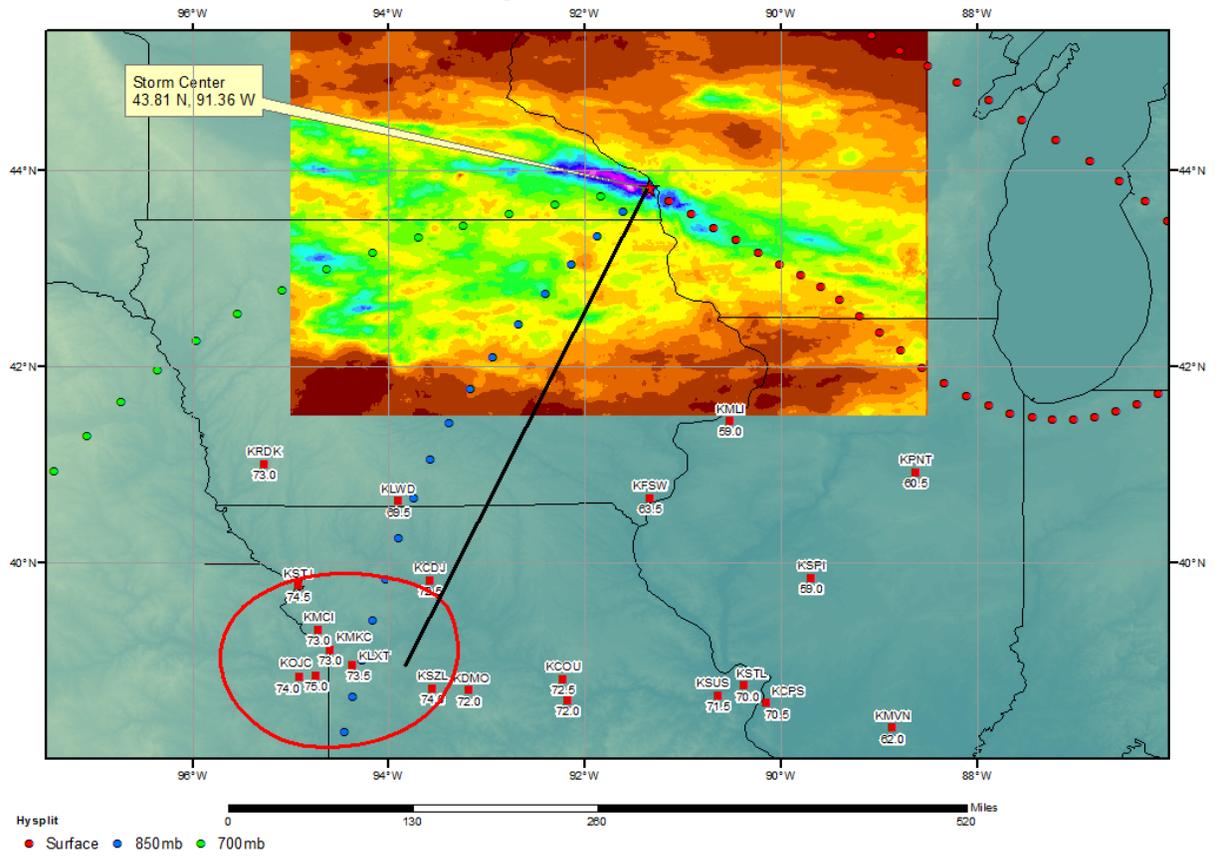
Coordinate system: GCS North American 1983
Scale: 1:4,350,819

MESSTANA May12, 2008

NOAA HYSPLIT MODEL
 Backward trajectories ending at 0700 UTC 19 Aug 07
 CDC1 Meteorological Data



SPAS 1048 Hokah, MN Storm Analysis August 17-18, 2007



Hybrid Storms

Storm Precipitation Analysis System (SPAS) For Storm #1699_1 SPAS Analysis

General Storm Location: Hayward, WI

Storm Dates: August 27-31, 1941

Event: Synoptic

DAD Zone 1

Latitude: 45.9958

Longitude: -91.0958

Max. Grid Rainfall Amount: 15.35"

Max. Observed Rainfall Amount: 15.31"

Number of Stations: 362

SPAS Version: 10.0

Basemap: 1699_isohyetal_sm

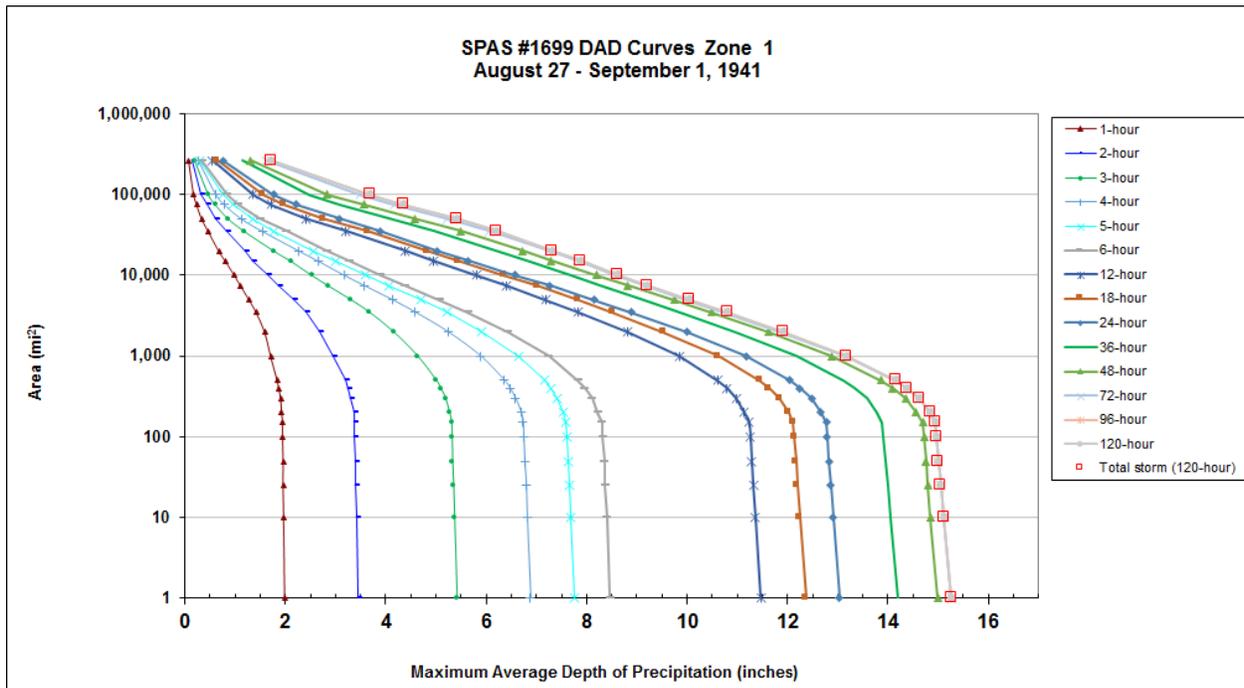
Spatial resolution: 0.2304

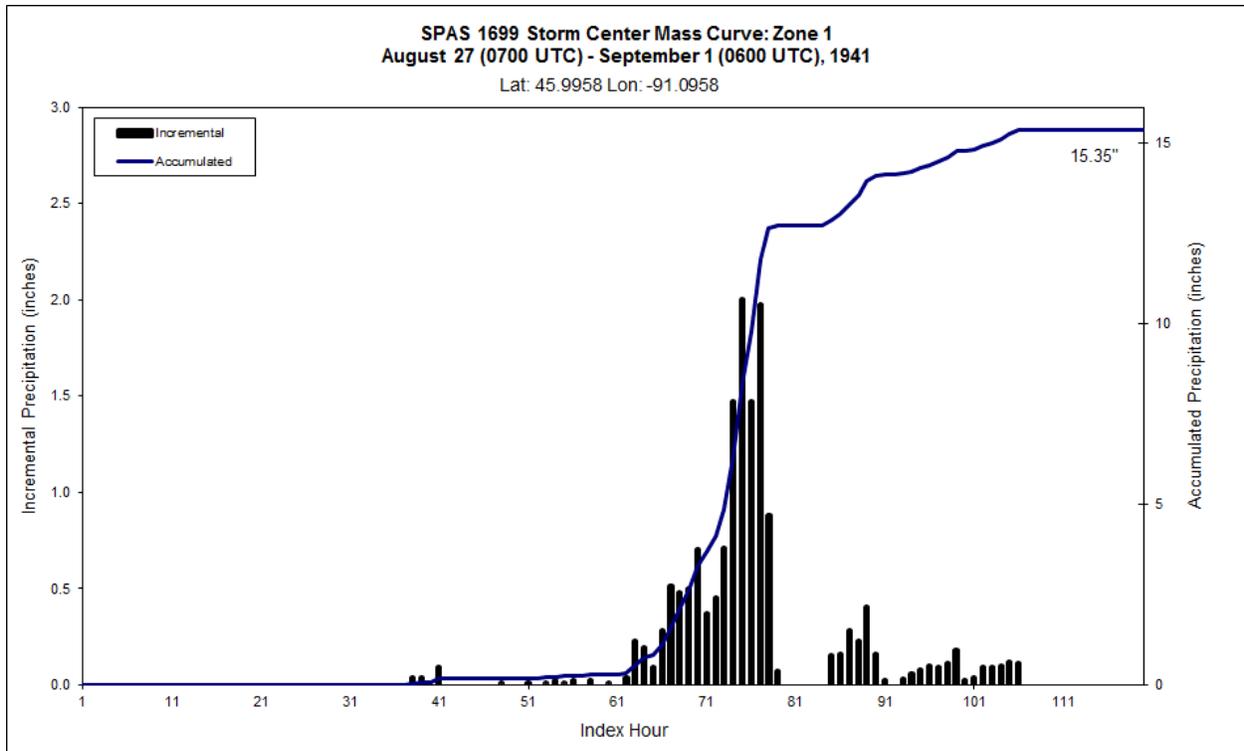
Radar Included: No

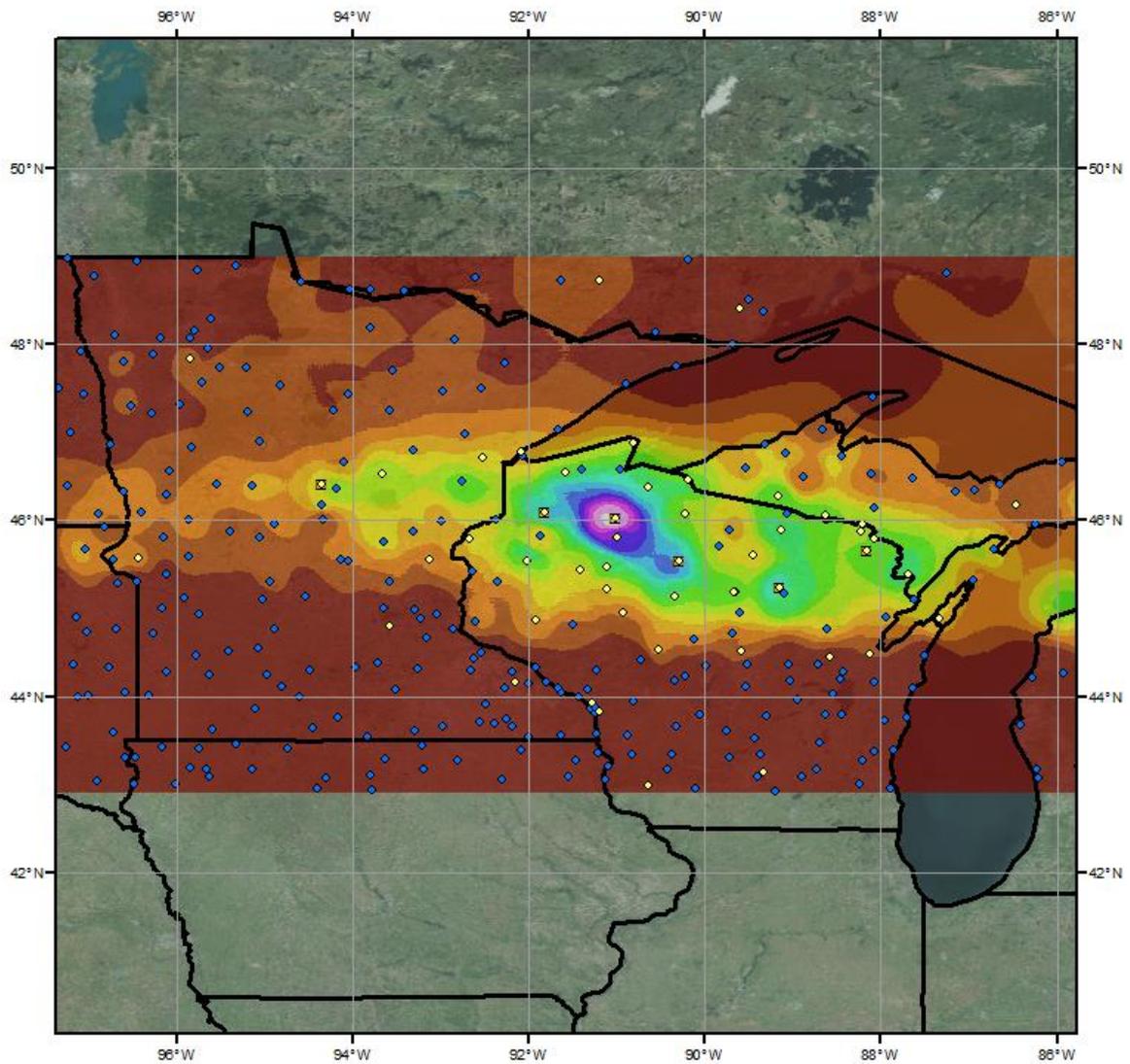
Depth-Area-Duration (DAD) analysis: Yes

Reliability of results: This analysis was based on 362 hourly pseudo stations, daily data and supplemental station data. We have a good degree of confidence for the station based storm total results. The spatial pattern is dependent on the USACE isohyetal basemap. Timing is based on the hourly pseudo stations. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

Storm 1699 - August 27 (0700 UTC) - September 1 (0600 UTC), 1941															
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)															
Area (mi ²)	Duration (hours)														Total
	1	2	3	4	5	6	12	18	24	36	48	72	96	120	
0.4	2.00	3.47	5.44	6.91	7.79	8.50	11.51	12.41	13.08	14.24	15.05	15.32	15.32	15.32	15.32
1	1.99	3.45	5.42	6.88	7.76	8.47	11.47	12.37	13.03	14.19	14.99	15.26	15.26	15.26	15.26
10	1.97	3.42	5.37	6.81	7.68	8.40	11.36	12.25	12.91	14.05	14.85	15.11	15.11	15.11	15.11
25	1.96	3.40	5.35	6.79	7.65	8.37	11.32	12.20	12.86	13.99	14.80	15.06	15.06	15.06	15.06
50	1.96	3.39	5.33	6.76	7.63	8.35	11.29	12.17	12.83	13.95	14.76	15.01	15.01	15.01	15.01
100	1.95	3.38	5.32	6.74	7.61	8.32	11.26	12.13	12.79	13.91	14.72	14.97	14.97	14.97	14.97
150	1.95	3.38	5.31	6.73	7.59	8.30	11.24	12.11	12.77	13.89	14.70	14.94	14.94	14.94	14.94
200	1.93	3.36	5.27	6.69	7.54	8.22	11.14	12.02	12.66	13.79	14.56	14.83	14.83	14.84	14.84
300	1.91	3.30	5.19	6.58	7.42	8.11	10.98	11.84	12.48	13.58	14.35	14.61	14.62	14.62	14.62
400	1.87	3.25	5.10	6.47	7.29	7.96	10.79	11.63	12.25	13.34	14.09	14.36	14.38	14.38	14.38
500	1.84	3.19	5.01	6.36	7.17	7.82	10.61	11.44	12.05	13.12	13.86	14.14	14.16	14.16	14.16
1,000	1.71	2.95	4.64	5.89	6.64	7.24	9.84	10.62	11.18	12.17	12.87	13.14	13.17	13.17	13.17
2,000	1.59	2.69	4.16	5.24	5.92	6.43	8.82	9.53	10.00	10.96	11.63	11.87	11.92	11.92	11.92
3,500	1.42	2.40	3.68	4.59	5.21	5.63	7.84	8.52	8.88	9.87	10.49	10.73	10.80	10.80	10.80
5,000	1.28	2.16	3.31	4.13	4.69	5.07	7.19	7.84	8.14	9.14	9.75	9.99	10.05	10.05	10.05
7,500	1.11	1.86	2.85	3.57	4.05	4.38	6.40	7.01	7.27	8.27	8.82	9.14	9.20	9.20	9.20
10,000	0.99	1.65	2.53	3.17	3.59	3.89	5.81	6.35	6.57	7.70	8.20	8.58	8.63	8.63	8.63
15,000	0.81	1.36	2.11	2.65	3.00	3.27	4.94	5.43	5.65	6.81	7.30	7.82	7.89	7.89	7.89
20,000	0.68	1.20	1.78	2.27	2.55	2.82	4.39	4.82	5.02	6.19	6.73	7.24	7.31	7.31	7.31
35,000	0.47	0.84	1.19	1.54	1.78	2.02	3.21	3.64	3.88	4.96	5.50	6.06	6.21	6.21	6.21
50,000	0.34	0.61	0.87	1.12	1.34	1.49	2.40	2.75	3.08	4.08	4.57	5.21	5.41	5.41	5.41
75,000	0.24	0.43	0.61	0.78	0.97	1.06	1.72	1.97	2.22	3.08	3.57	4.18	4.35	4.35	4.35
100,000	0.18	0.33	0.47	0.61	0.77	0.84	1.36	1.56	1.76	2.48	2.84	3.49	3.69	3.69	3.69
263,732	0.08	0.14	0.20	0.26	0.30	0.34	0.55	0.64	0.76	1.14	1.31	1.62	1.71	1.71	1.71







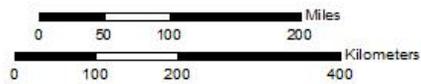
Total Storm (120-hours) Precipitation (inches)

August 27-31, 1941

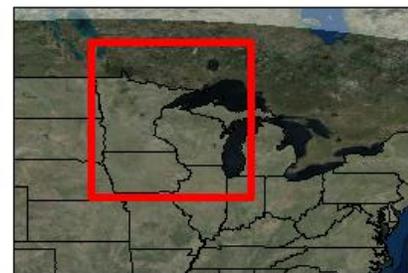
SPAS 1699 - Haywood, WI

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental



Precipitation (inches)	
0.00 - 1.00	5.01 - 6.00
1.01 - 2.00	6.01 - 7.00
2.01 - 3.00	7.01 - 8.00
3.01 - 4.00	8.01 - 9.00
4.01 - 5.00	9.01 - 10.00
	10.01 - 11.00
	11.01 - 12.00
	12.01 - 13.00
	13.01 - 14.00
	14.01 - 15.00
	15.01 - 16.00



WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES - PERTINENT DATA SHEET



Storm of August 28 - 31, 1941
 Assignment U M V 1 - 22
 Location Northern Wisconsin and
 Study Prepared by: Minn.
 Upper Mississippi Valley
 Division
 St. Paul District Office
 Part I Reviewed by H. M. Sec. of
 Weather Bureau, 3/24/42
 Part II Approved by Office, Chief
 of Engineers for Distribution
 of Factual Data, 4/11/45
 Remarks: Center at:
 Baywood and Moose Lake, Wisc.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 4 sheet, scale 1 : 1,000,000
 Precipitation data and mass curves: (Number of Sheets)
 Form 5001-C (Hourly precip. data)----- 33
 Form 5001-B (24-hour " ")----- -
 Form 5001-D (" " " ")----- 14
 Misc. precip. records, meteorological data, etc.----- 3
 Form 5002 (Mass rainfall curves)----- 42

PART II

Final isohyetal maps, in 1 sheet, scale 1,000,000
 Data and computation sheets:
 Form S-10 (Data from mass rainfall curves)----- 6
 Form S-11 (Depth-area data from isohyetal map)----- 2
 Form S-12 (Maximum depth-duration data)----- 8
 Maximum duration-depth-area curves----- 1
 Data relating to periods of maximum rainfall----- 2

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

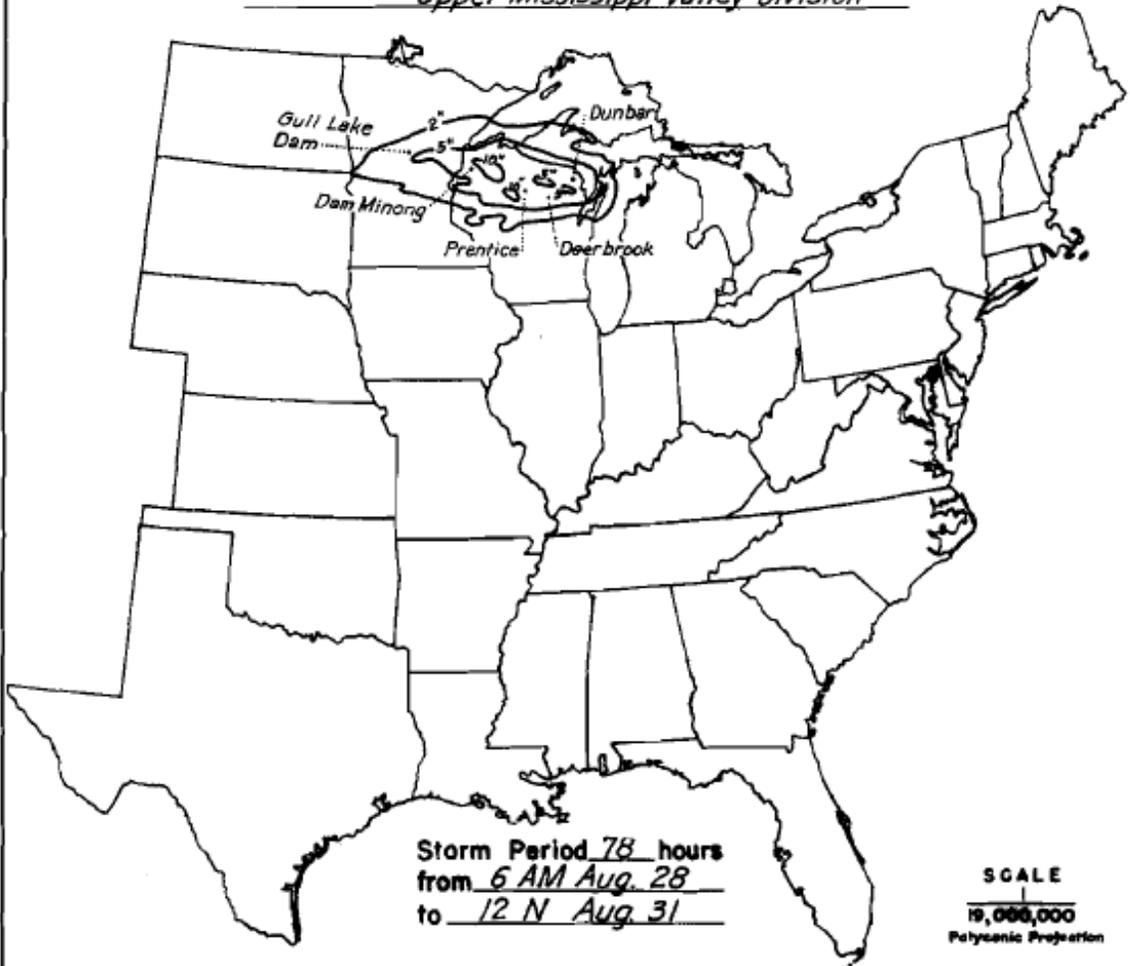
Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	78
10	8.5	11.5	12.4	12.4	13.3	13.8	14.4	15.0	15.0	15.0
100	8.1	11.0	11.8	11.8	12.7	13.3	13.8	14.3	14.5	14.5
200	7.8	10.6	11.3	11.3	12.3	13.0	13.4	13.9	14.1	14.1
500	6.8	9.5	10.2	10.3	11.2	12.0	12.5	12.9	13.1	13.1
1,000	5.6	8.2	9.0	9.1	10.0	10.9	11.5	11.9	12.0	12.0
2,000	4.3	6.9	7.7	7.9	8.8	9.7	10.4	10.8	10.9	10.9
5,000	3.0	5.2	5.9	6.3	7.2	8.1	8.9	9.3	9.5	9.5
10,000	2.1	3.8	4.6	5.1	5.9	6.8	7.8	8.2	8.4	8.4
20,000	1.5	2.7	3.4	3.8	4.7	5.5	6.5	7.1	7.3	7.3
50,000	0.9	1.6	2.1	2.5	3.1	3.6	4.5	5.1	5.2	5.2
60,000	0.8	1.4	1.9	2.2	2.8	3.3	4.1	4.5	4.7	4.7

WAR DEPARTMENT

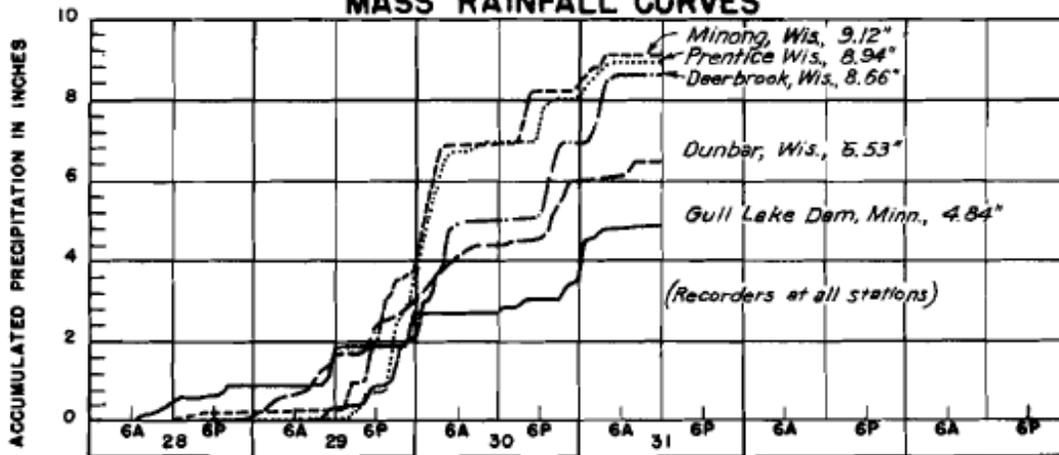
CORPS OF ENGINEERS, U. S. ARMY

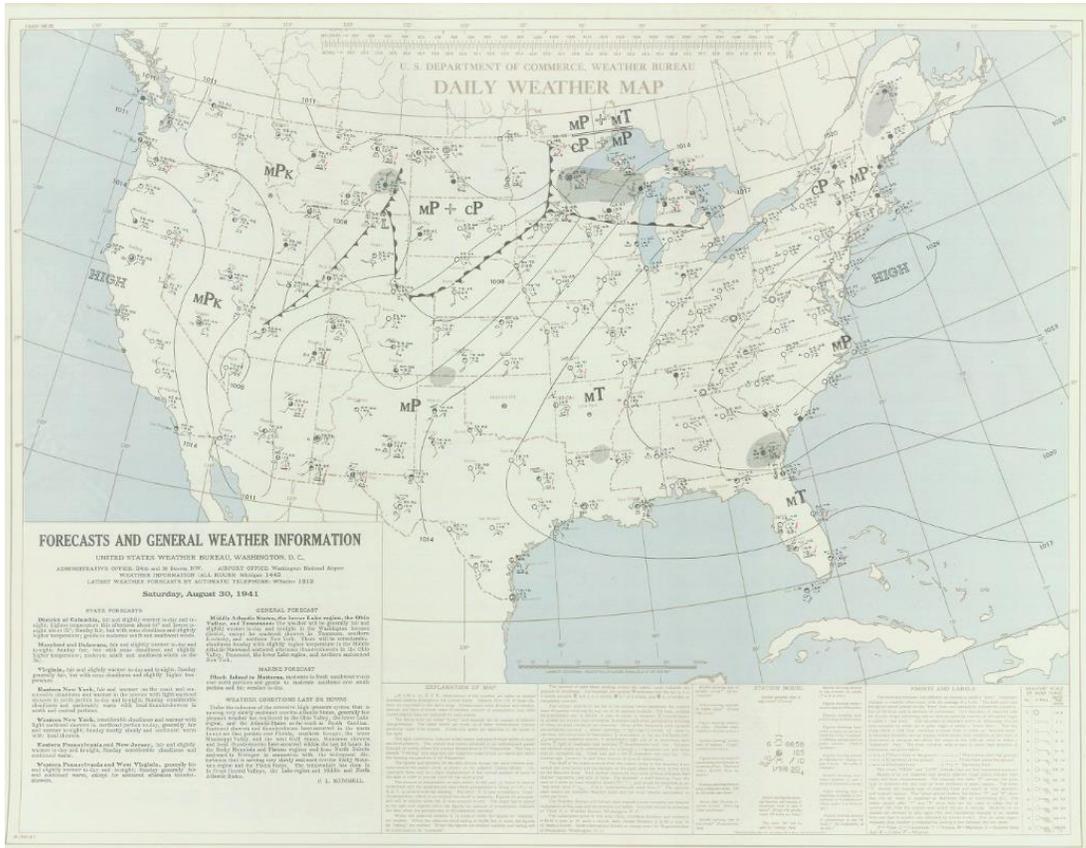
STORM STUDIES - ISOHYETAL MAP

Storm of August 28-31, 1941 Assignment UMV 1-22
 Study Prepared by: St. Paul, Minn. District
Upper Mississippi Valley Division

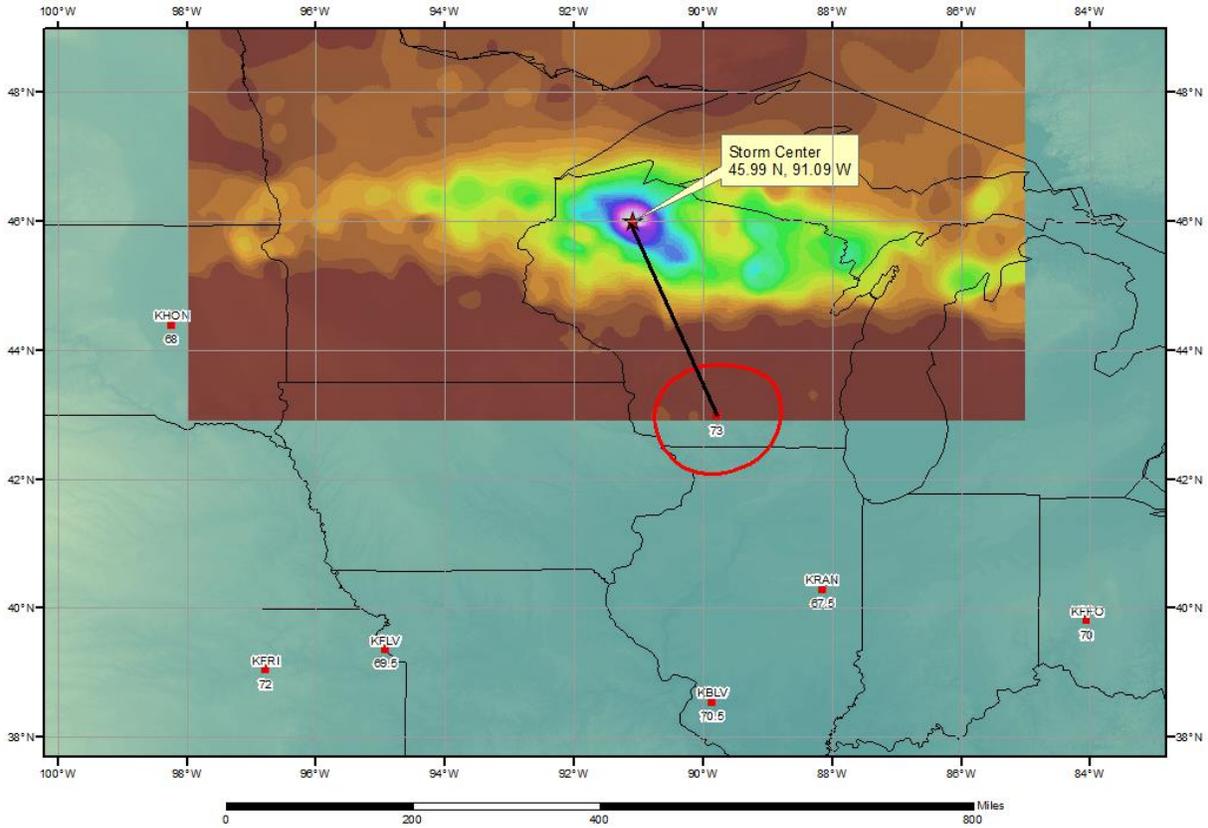


MASS RAINFALL CURVES





SPAS 1699 Hayward, WI (UMV 1-22) Storm Analysis August 27-31, 1941



Storm Precipitation Analysis System (SPAS) For Storm #1183_1 SPAS Analysis

General Storm Location: Edgerton, Missouri

Storm Dates: July 18-20, 1965

Event: Synoptic

DAD Zone 1

Latitude: 40.4125

Longitude: -95.5125

Max. Grid Rainfall Amount: 20.76"

Max. Observed Rainfall Amount: 20.10" at ATCHISON 65N 41W SCT34

Number of Stations: 387 (90 Daily, 41 Hourly, 4 Hourly Estimated, 2 Hourly Estimated Pseudo, 13 Hourly Pseudo, and 237 Supplemental)

SPAS Version: 8.5

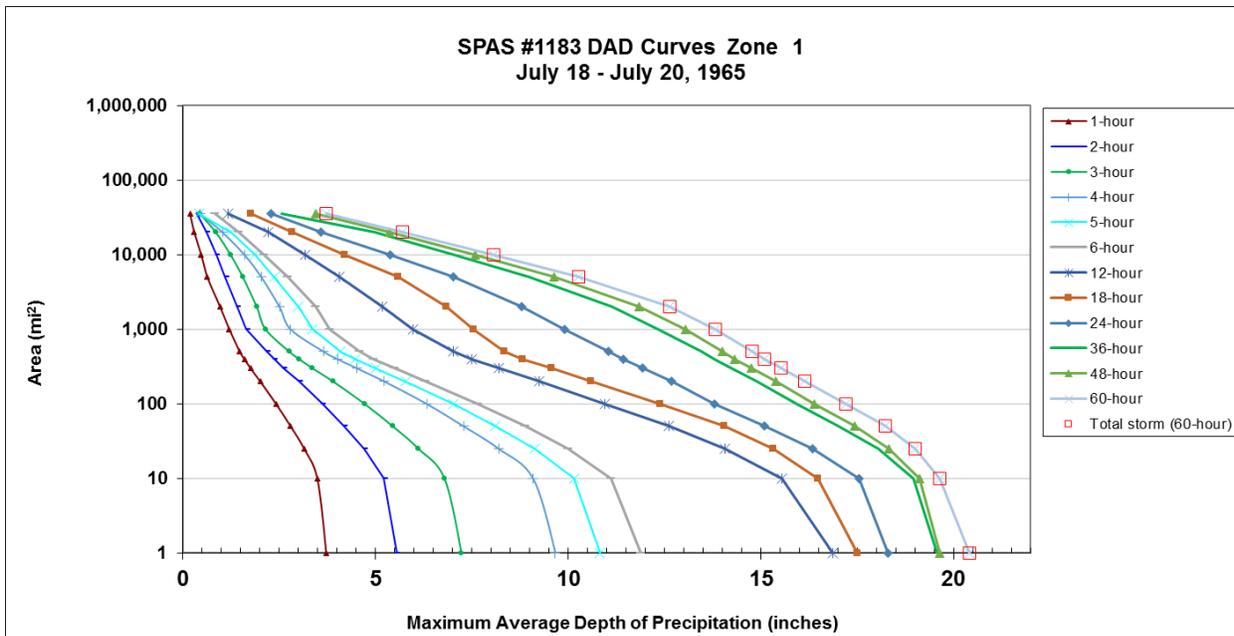
Base Map Used: Yes, conus_prism_ppt_in_1971_2000_07

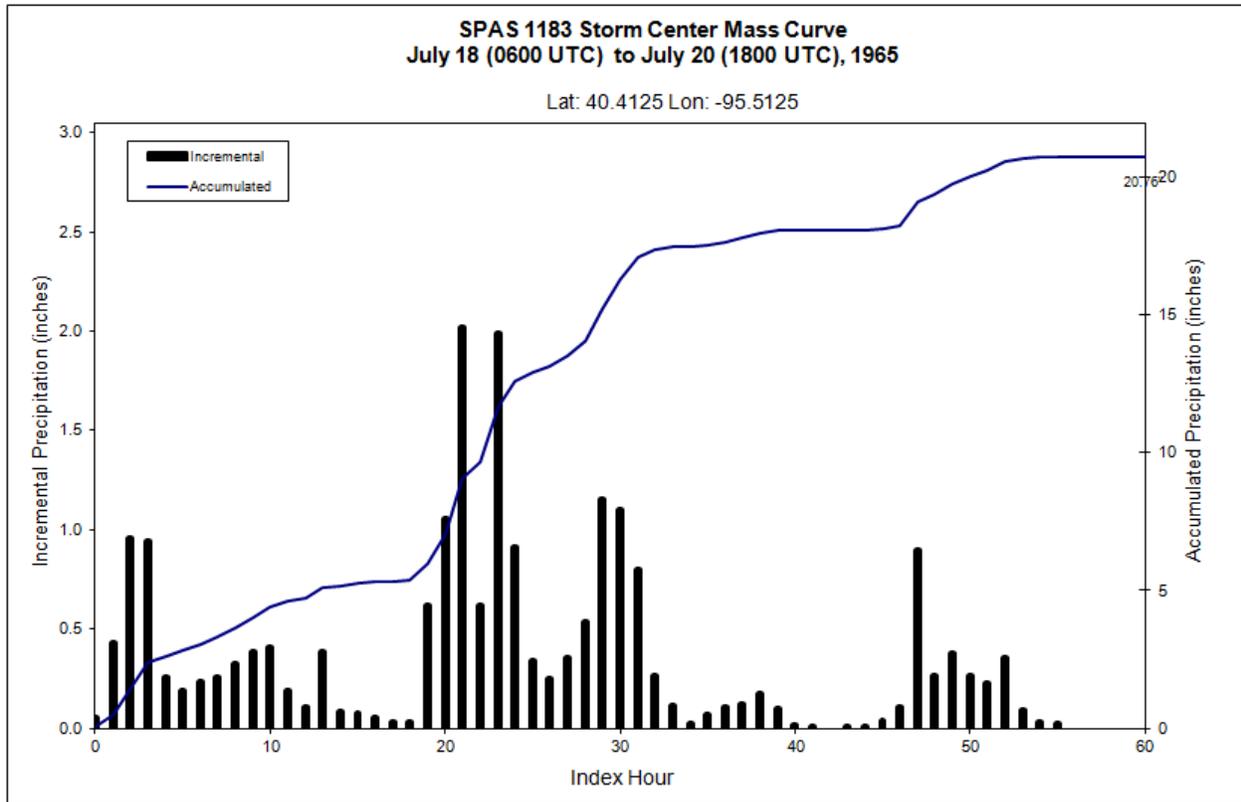
Spatial resolution: 00:00:30 (0.3 sq. miles)

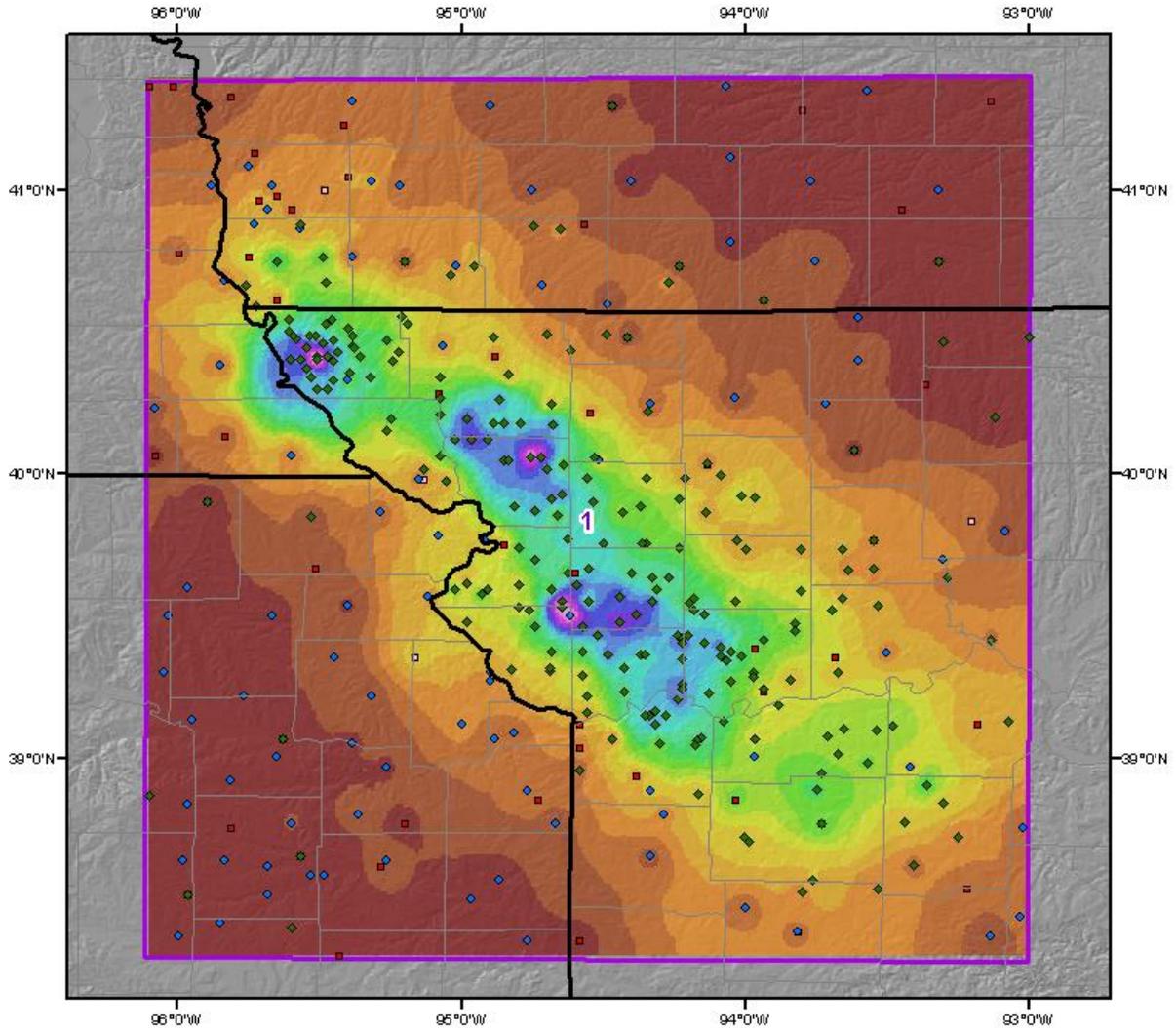
Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes

Storm 1183 - July 18 (0600 UTC) - July 20 (1800 UTC), 1965													
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)													
Area (mi ²)	Duration (hours)												
	1	2	3	4	5	6	12	18	24	36	48	60	Total
0.4	3.75	5.61	7.30	9.78	10.92	12.00	17.04	17.70	18.50	19.74	19.79	20.64	20.64
1	3.72	5.55	7.23	9.67	10.82	11.88	16.86	17.51	18.30	19.58	19.64	20.41	20.41
10	3.49	5.22	6.79	9.09	10.15	11.11	15.55	16.48	17.56	18.95	19.11	19.63	19.63
25	3.15	4.71	6.12	8.20	9.14	10.00	14.06	15.33	16.35	18.05	18.33	19.01	19.01
50	2.80	4.18	5.45	7.29	8.12	8.88	12.61	14.04	15.09	17.00	17.44	18.24	18.24
100	2.42	3.62	4.72	6.33	7.02	7.65	10.96	12.38	13.79	15.93	16.40	17.21	17.21
200	2.01	3.02	3.90	5.23	5.79	6.30	9.25	10.59	12.69	14.90	15.38	16.13	16.13
300	1.76	2.62	3.37	4.52	5.01	5.49	8.21	9.56	11.94	14.24	14.75	15.52	15.52
400	1.60	2.36	3.02	4.01	4.47	4.95	7.51	8.81	11.43	13.79	14.33	15.10	15.10
500	1.48	2.18	2.77	3.66	4.09	4.58	7.03	8.34	11.05	13.45	14.00	14.78	14.78
1,000	1.21	1.65	2.15	2.80	3.37	3.82	5.97	7.55	9.92	12.35	13.05	13.83	13.83
2,000	0.97	1.41	1.92	2.51	3.00	3.46	5.17	6.84	8.80	11.13	11.85	12.63	12.63
5,000	0.64	1.10	1.56	2.04	2.38	2.73	4.06	5.59	7.02	8.97	9.64	10.28	10.28
10,000	0.48	0.86	1.24	1.60	1.86	2.10	3.18	4.21	5.38	7.05	7.59	8.07	8.07
20,000	0.30	0.61	0.86	1.03	1.25	1.45	2.23	2.84	3.58	4.98	5.36	5.71	5.71
35,221	0.19	0.37	0.45	0.46	0.43	0.83	1.17	1.78	2.29	2.57	3.46	3.72	3.72



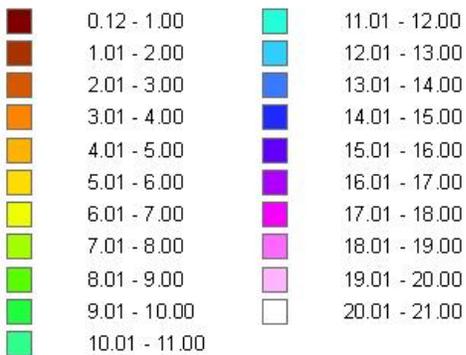




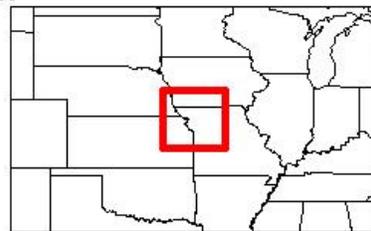
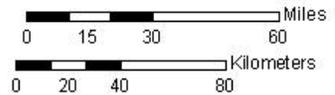
Total Precipitation (60-hours)
SPAS storm number: 1183
July 18, 1965 (0600 UTC) - July 20, 1965 (1800 UTC)



Precipitation (inches)

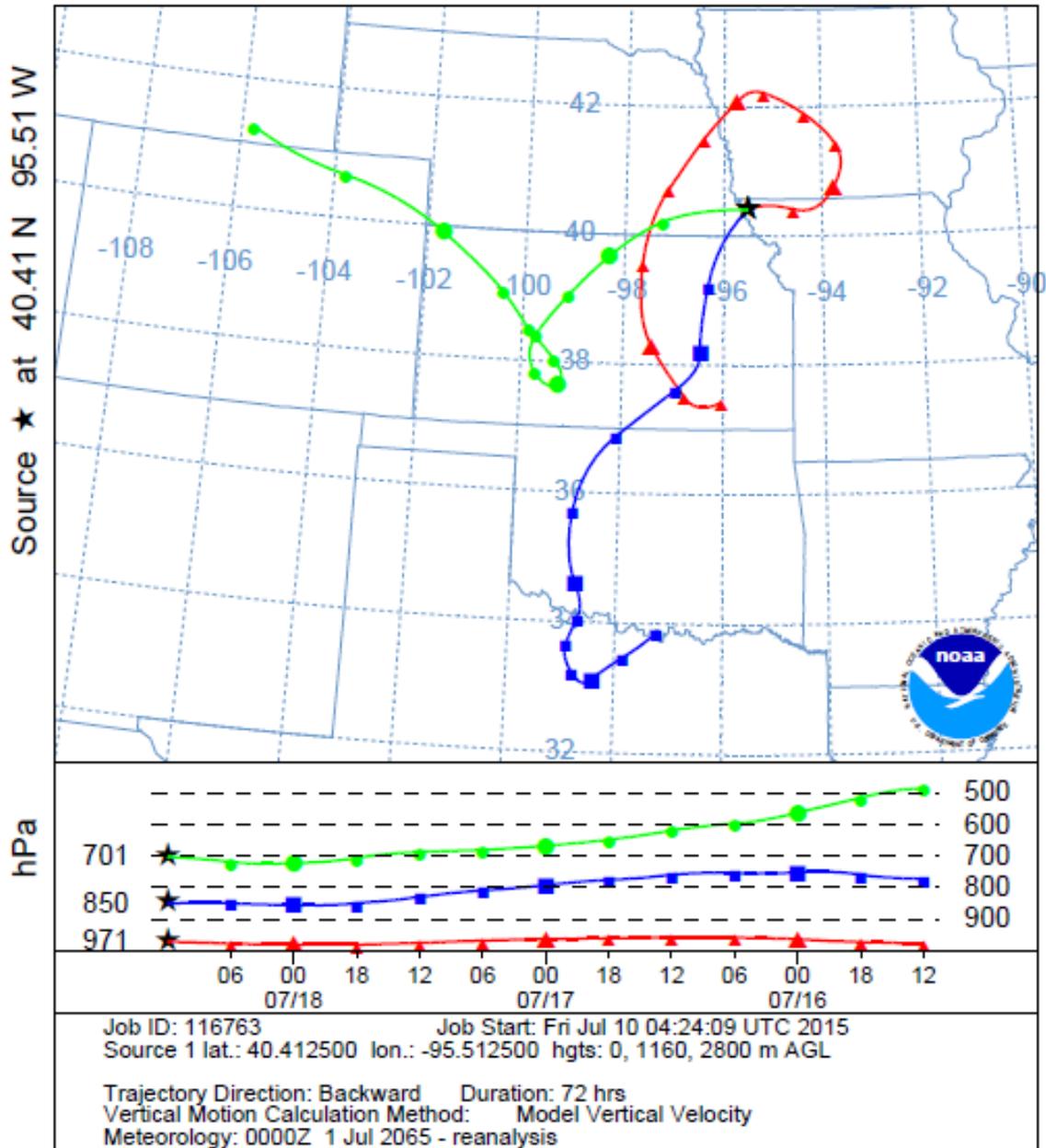


- Daily
- Hourly
- Hourly Estimated
- Hourly Estimated Pseudo
- Hourly Pseudo
- Supplemental

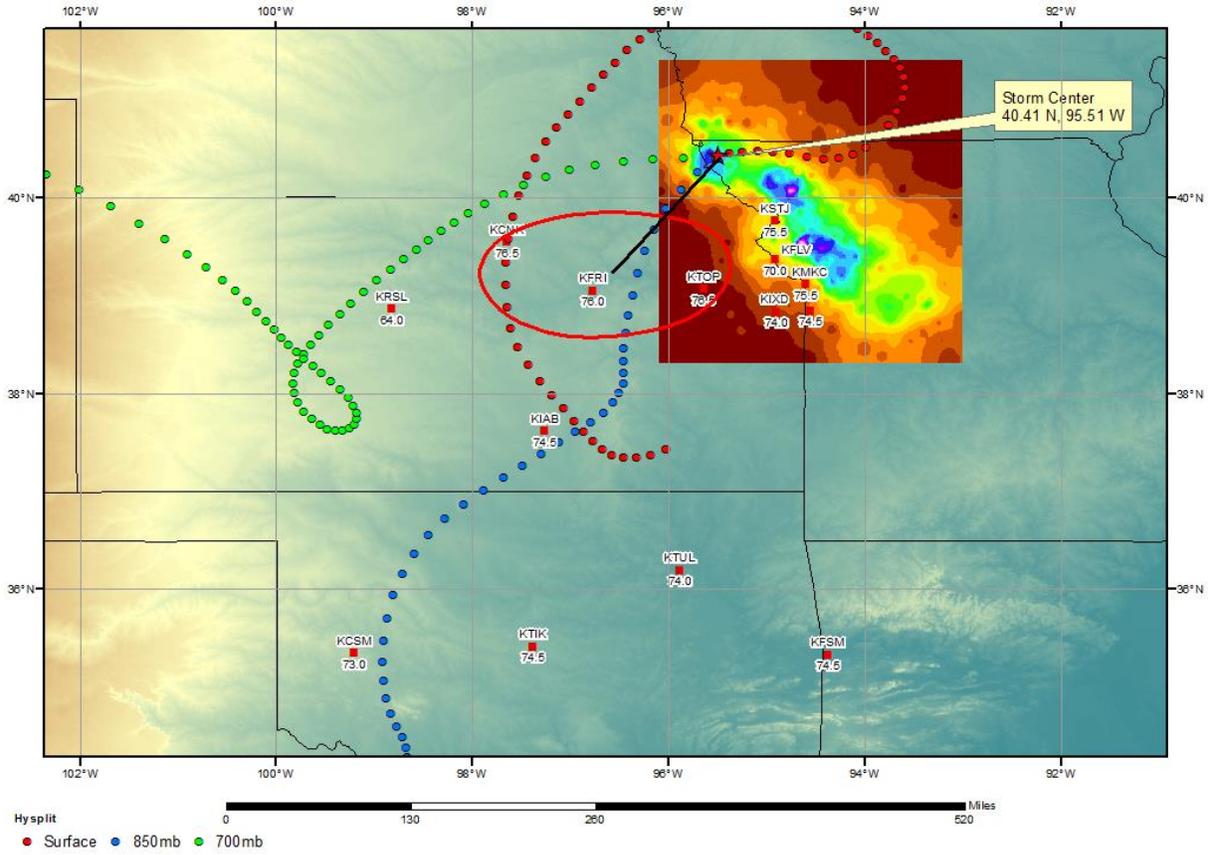


NE S&B FAWA May 20, 2010

NOAA HYSPLIT MODEL
 Backward trajectories ending at 1200 UTC 18 Jul 65
 CDC1 Meteorological Data



SPAS 1183 Edgerton, MO Storm Analysis July 16-19, 1965



Storm Precipitation Analysis System (SPAS) For Storm #1725_1 SPAS Analysis

General Storm Location: Leonard, ND

Storm Dates: June 27-30, 1975

Event: Local

DAD Zone 1

Latitude: 46.5958

Longitude: -97.3375

Max. Grid Rainfall Amount: 20.66"

Max. Observed Rainfall Amount: 20.00"

Number of Stations: 83

SPAS Version: 10.0

Base Map Used: USGS Report Isohyetal Image

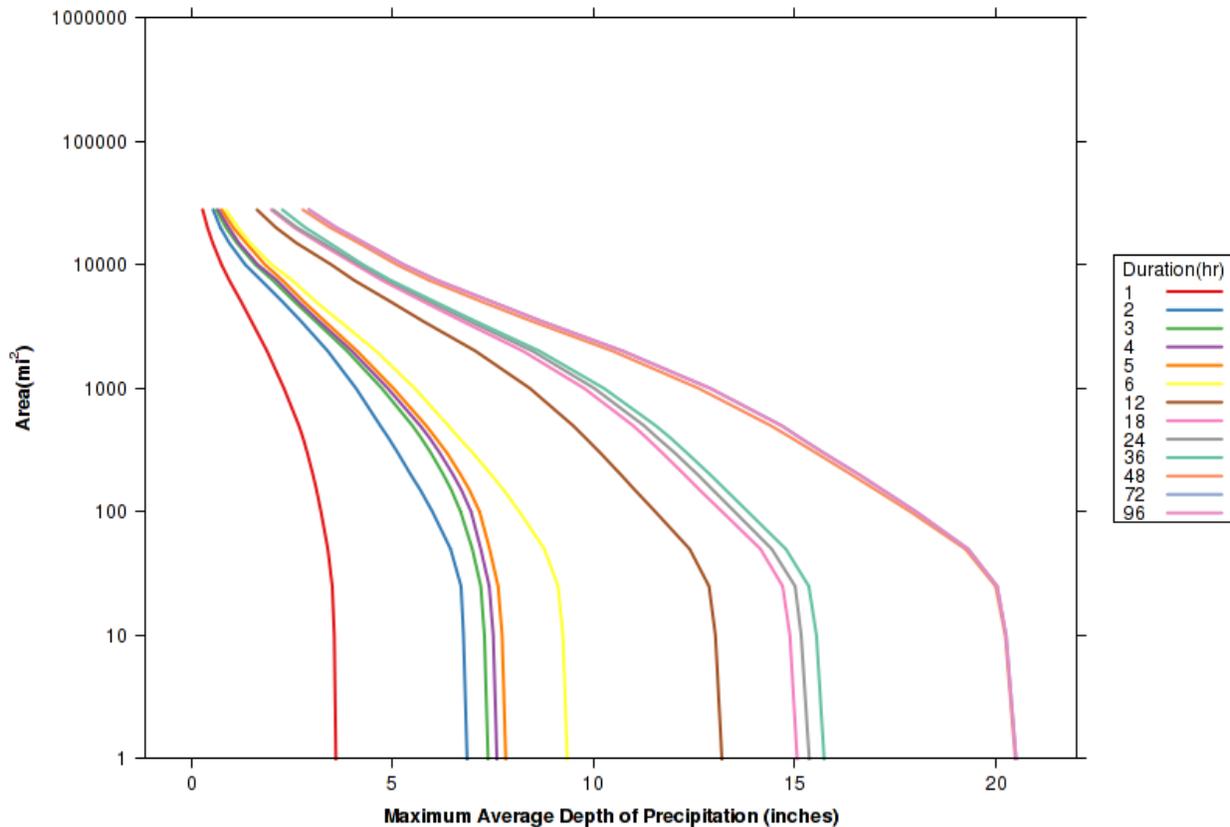
Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes

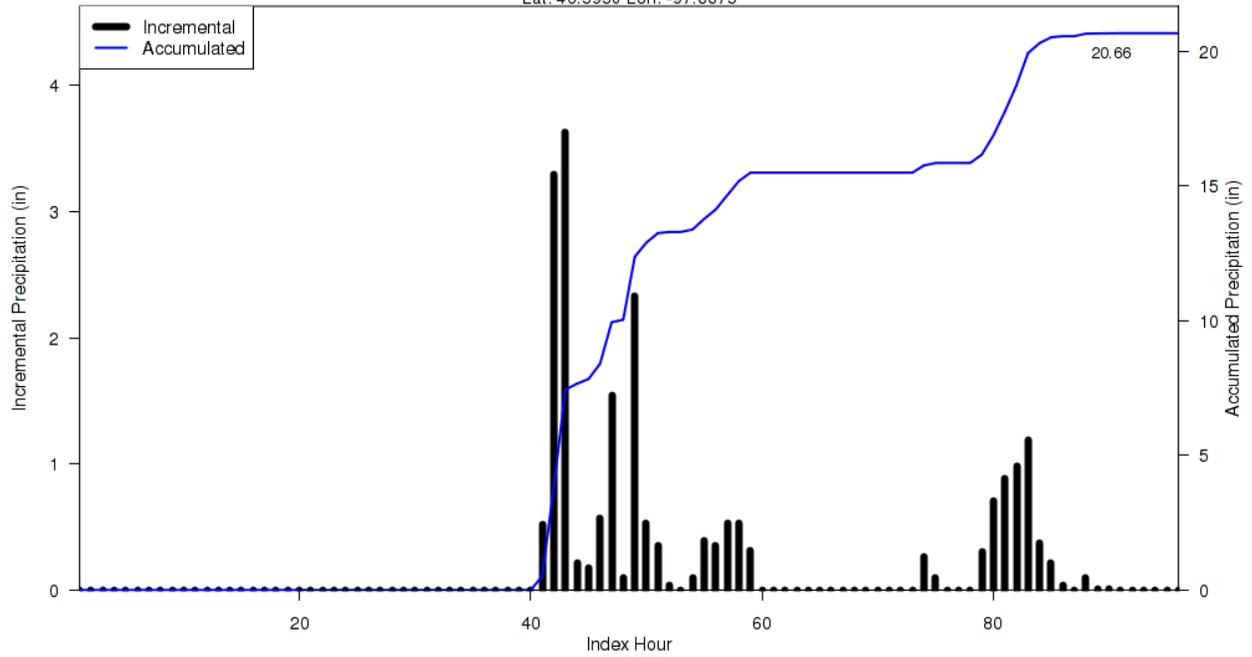
Reliability of Results: This analysis was based on 83 hourly stations, daily data, and supplemental station data. We have a good degree of confidence for the station based storm total results. The spatial pattern is fully dependent on the basemap created from the USGS Isohyetal image. Timing is based on the 13 hourly stations (see Miscellaneous notes below). Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

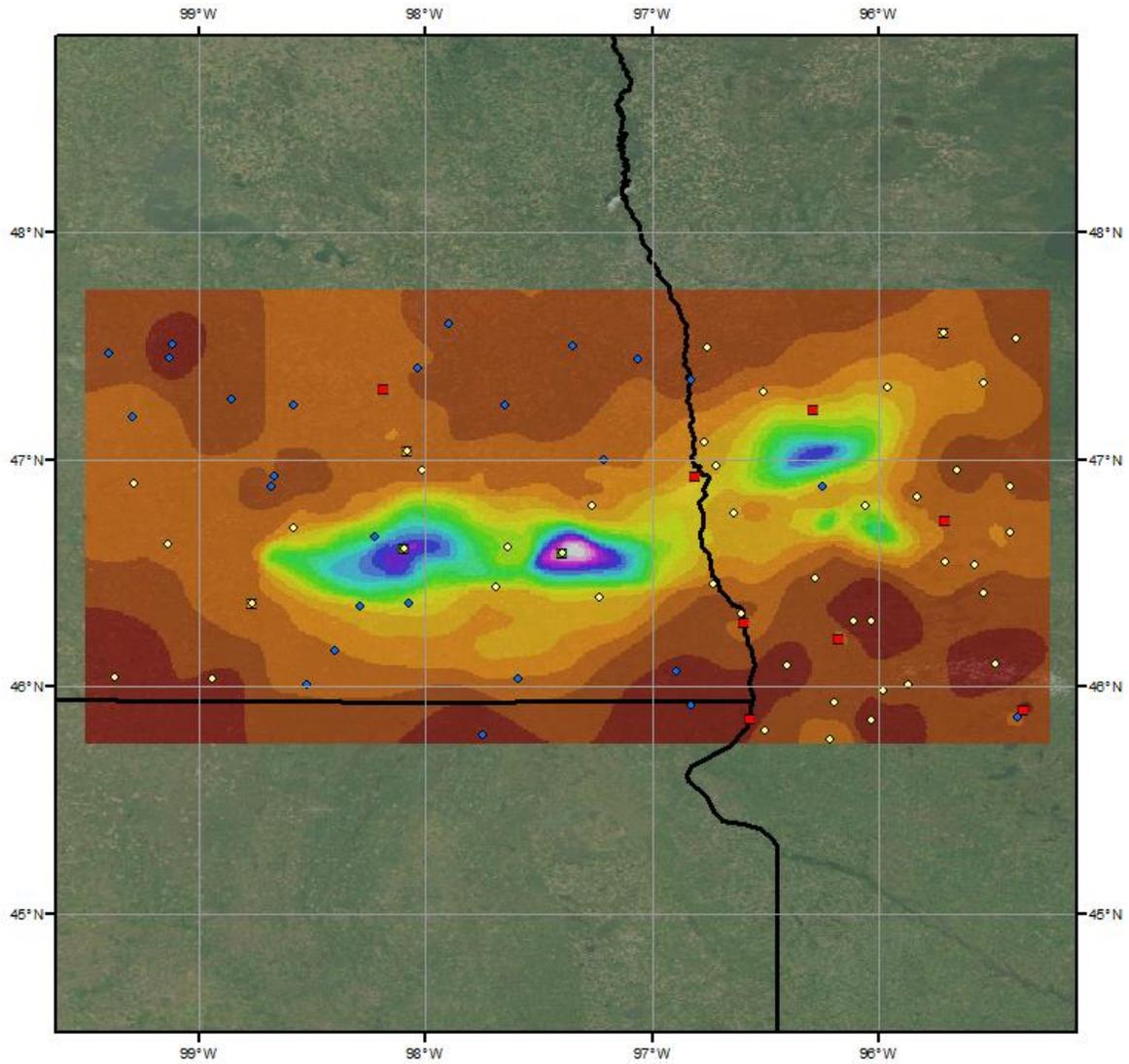
Storm 1725 - June 27 (0600 UTC) - July 1 (0500 UTC), 1975										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	6	12	18	24	36	48	72	96	Total
0.4	3.62	9.39	13.25	15.13	15.44	15.80	20.58	20.60	20.60	20.60
1	3.60	9.35	13.19	15.06	15.36	15.73	20.48	20.50	20.50	20.50
10	3.56	9.24	13.03	14.88	15.16	15.54	20.23	20.25	20.25	20.25
25	3.51	9.12	12.87	14.70	15.01	15.35	19.99	20.03	20.03	20.03
50	3.40	8.78	12.39	14.15	14.43	14.78	19.24	19.31	19.31	19.31
100	3.23	8.16	11.54	13.20	13.51	13.84	17.88	18.02	18.02	18.02
200	3.03	7.46	10.68	12.26	12.59	12.90	16.41	16.60	16.60	16.60
300	2.89	7.00	10.17	11.71	12.02	12.32	15.53	15.72	15.72	15.72
400	2.78	6.65	9.79	11.31	11.58	11.90	14.90	15.12	15.12	15.12
500	2.68	6.39	9.49	10.98	11.25	11.54	14.40	14.67	14.67	14.67
1,000	2.31	5.56	8.42	9.77	10.02	10.26	12.61	12.90	12.90	12.90
2,000	1.89	4.60	7.07	8.25	8.49	8.66	10.48	10.73	10.73	10.73
5,000	1.25	3.11	4.97	5.79	5.94	6.07	7.24	7.49	7.49	7.49
10,000	0.76	2.01	3.49	4.09	4.19	4.28	5.12	5.29	5.29	5.29
20,000	0.41	1.17	2.11	2.56	2.63	2.84	3.46	3.61	3.61	3.61

SPAS 1725 DAD Curves Zone 1
June 27 (0600UTC) to July 1 (0500UTC), 1975



SPAS 1725 Storm Center Mass Curve Zone 1
June 27 (0600UTC) to July 1 (0500UTC), 1975
Lat: 46.5958 Lon: -97.3375





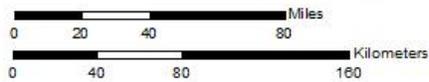
Total Storm (96-hours) Precipitation (inches)

June 27-30, 1975

SPAS 1725 - Leonard, ND

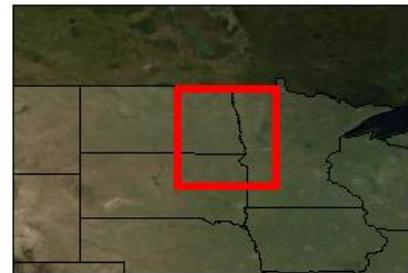
Gauges

- ◆ Daily
- Hourly
- HEP
- Hourly Pseudo
- ◇ Supplemental
- ◆ SE

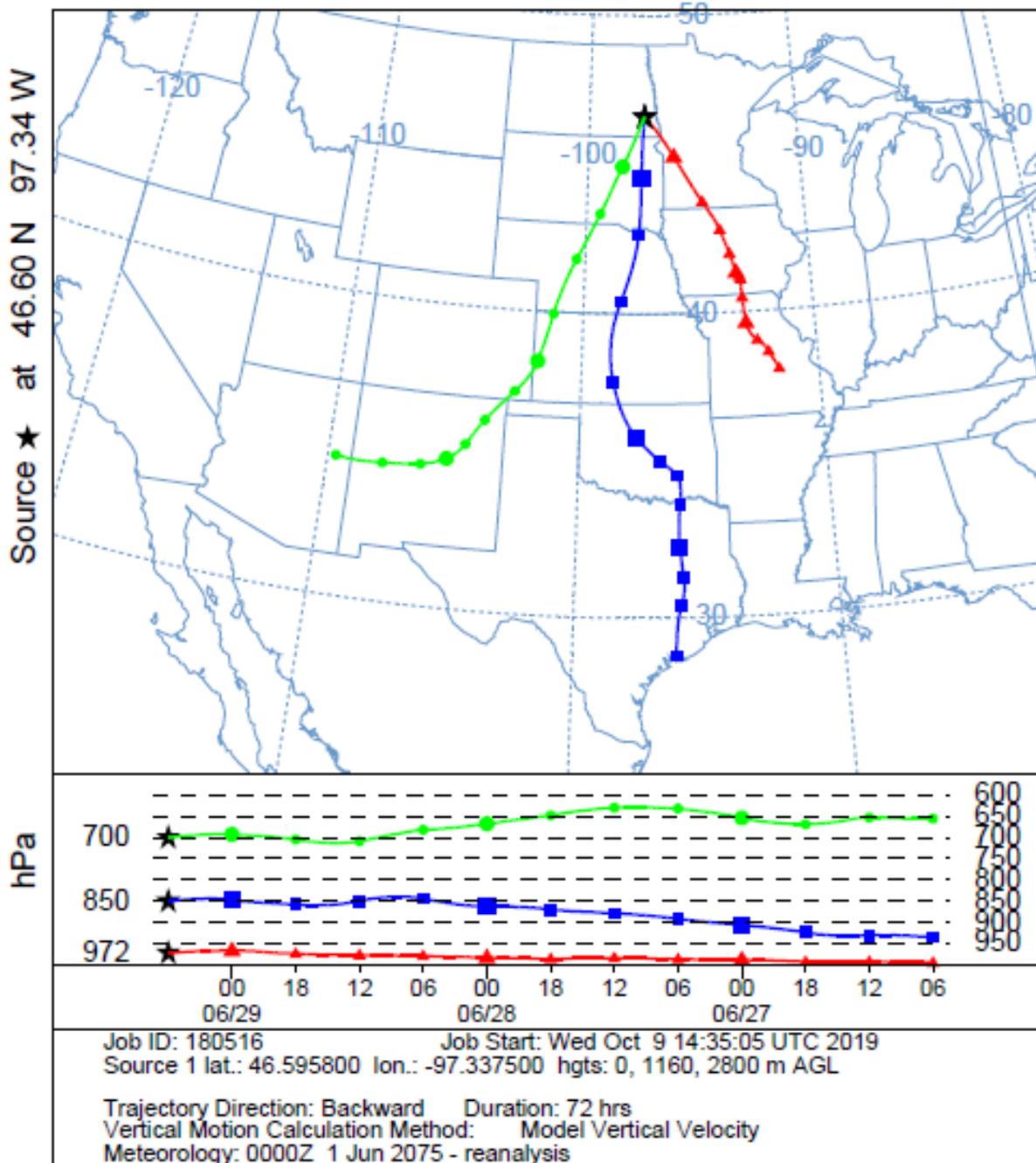


Precipitation (inches)

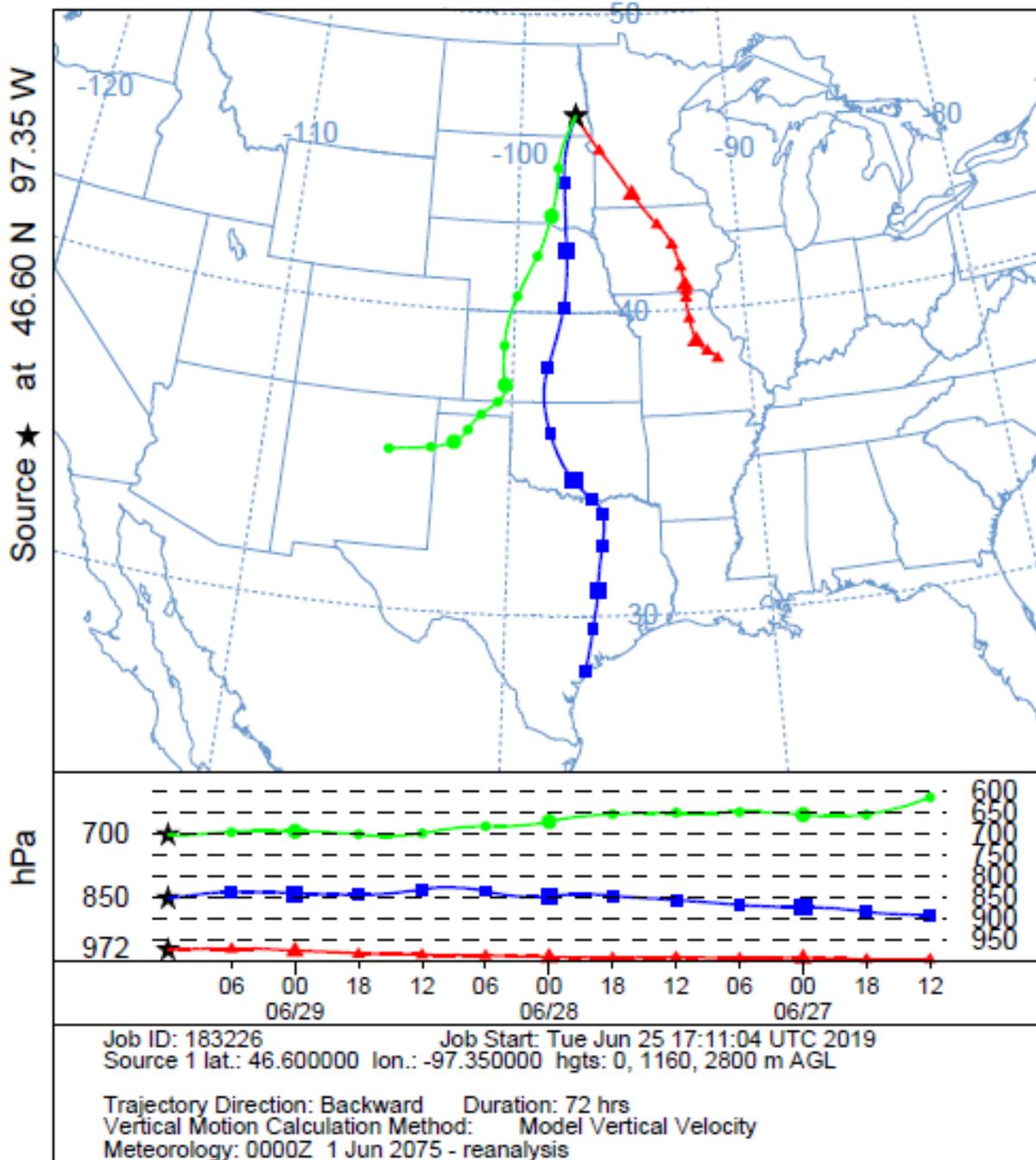
■ 0.00 - 1.00	■ 5.01 - 6.00	■ 11.01 - 12.00	■ 17.01 - 18.00
■ 1.01 - 2.00	■ 6.01 - 7.00	■ 12.01 - 13.00	■ 18.01 - 19.00
■ 2.01 - 3.00	■ 7.01 - 8.00	■ 13.01 - 14.00	■ 19.01 - 20.00
■ 3.01 - 4.00	■ 8.01 - 9.00	■ 14.01 - 15.00	■ 20.01 - 21.00
■ 4.01 - 5.00	■ 9.01 - 10.00	■ 15.01 - 16.00	
	■ 10.01 - 11.00	■ 16.01 - 17.00	



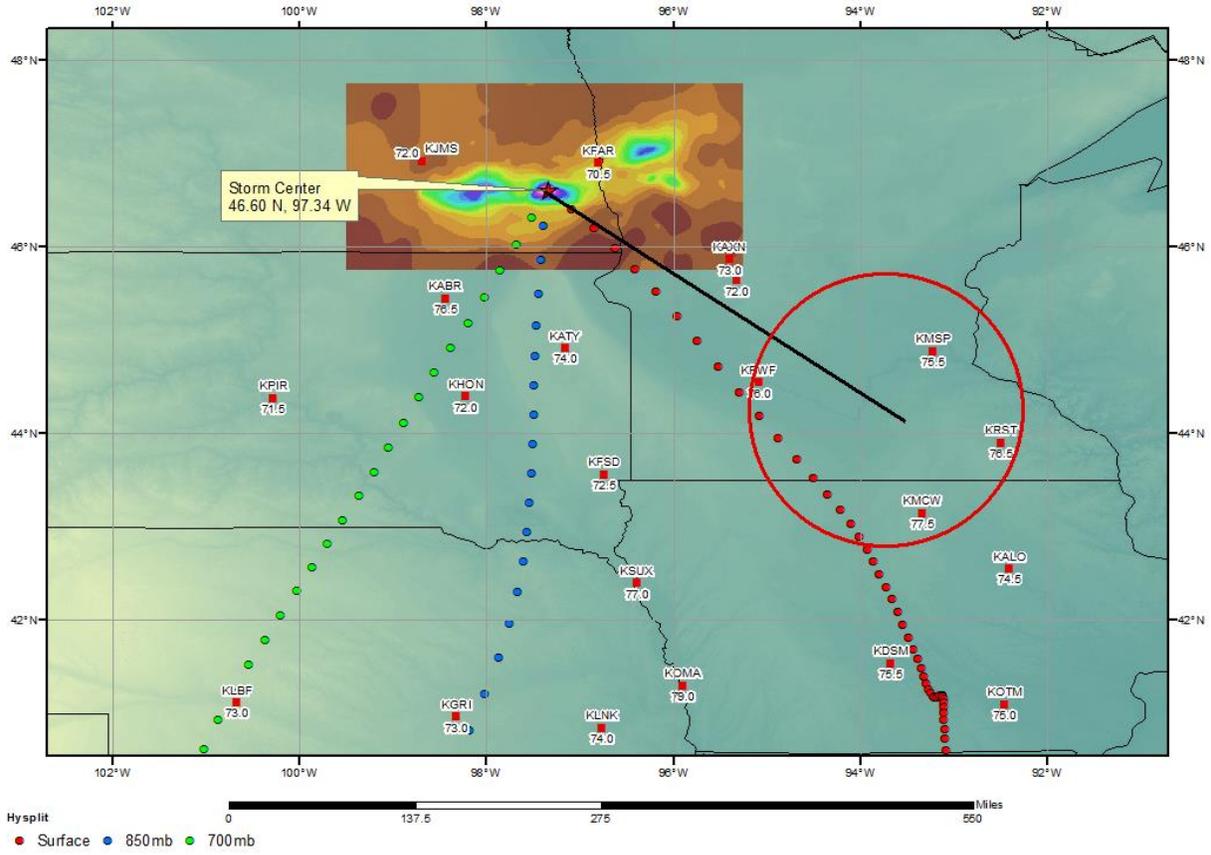
NOAA HYSPLIT MODEL
 Backward trajectories ending at 0600 UTC 29 Jun 75
 CDC1 Meteorological Data



NOAA HYSPLIT MODEL Backward trajectories ending at 1200 UTC 29 Jun 75 CDC1 Meteorological Data



SPAS 1725 - Leonard, ND Storm Analysis June 28-29, 1975



Storm Precipitation Analysis System (SPAS) For Storm #1286_1 SPAS Analysis

General Storm Location: Northern Illinois (Aurora College, IL)

Storm Dates: July 17, 1996 0100 UTC – July 19, 1996 0000 UTC (48 hours)

Event: Mesoscale convective complex (MCC)

DAD Zone 1

Latitude: 41.4575

Longitude: -88.0699

Max. Grid Rainfall Amount: 18.13"

Number of Stations: 173

- 86 daily
- 28 hourly
- 32 hourly pseudo
- 26 supplemental
- 1 supplemental estimated

SPAS Version: 10.0

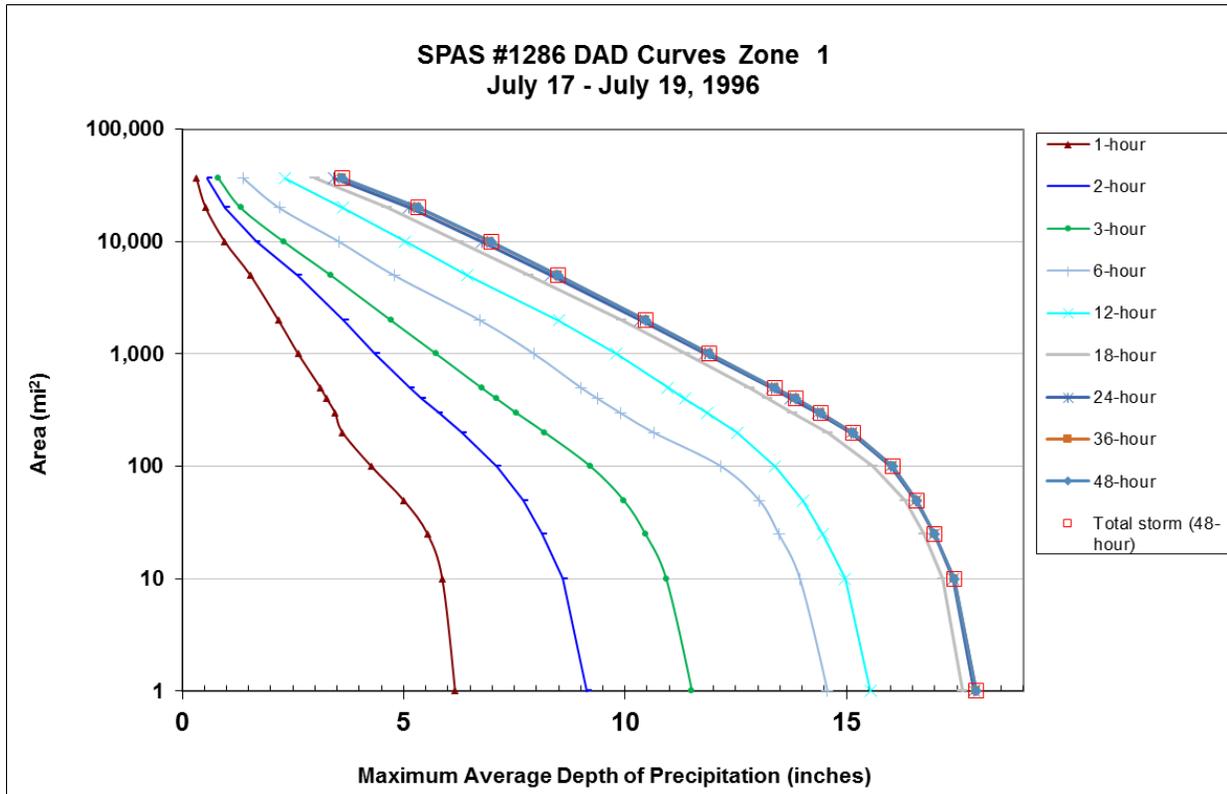
Base Map Used: 1981-2010 Mean July Precipitation (PRISM)

Radar Included: Yes (KMKX, KLOT and KIND)

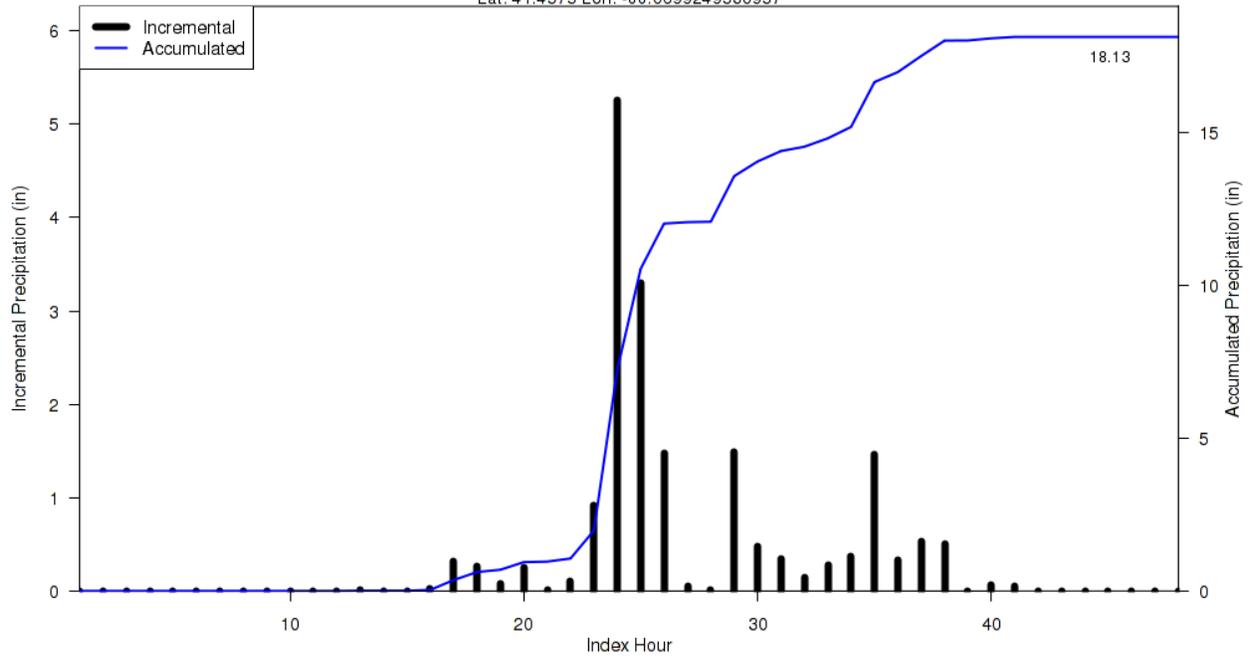
Depth-Area-Duration (DAD) analysis: Yes, 1, 2, 3, 4, 5, 6, 12, 18, 24, 36 and 48 hours

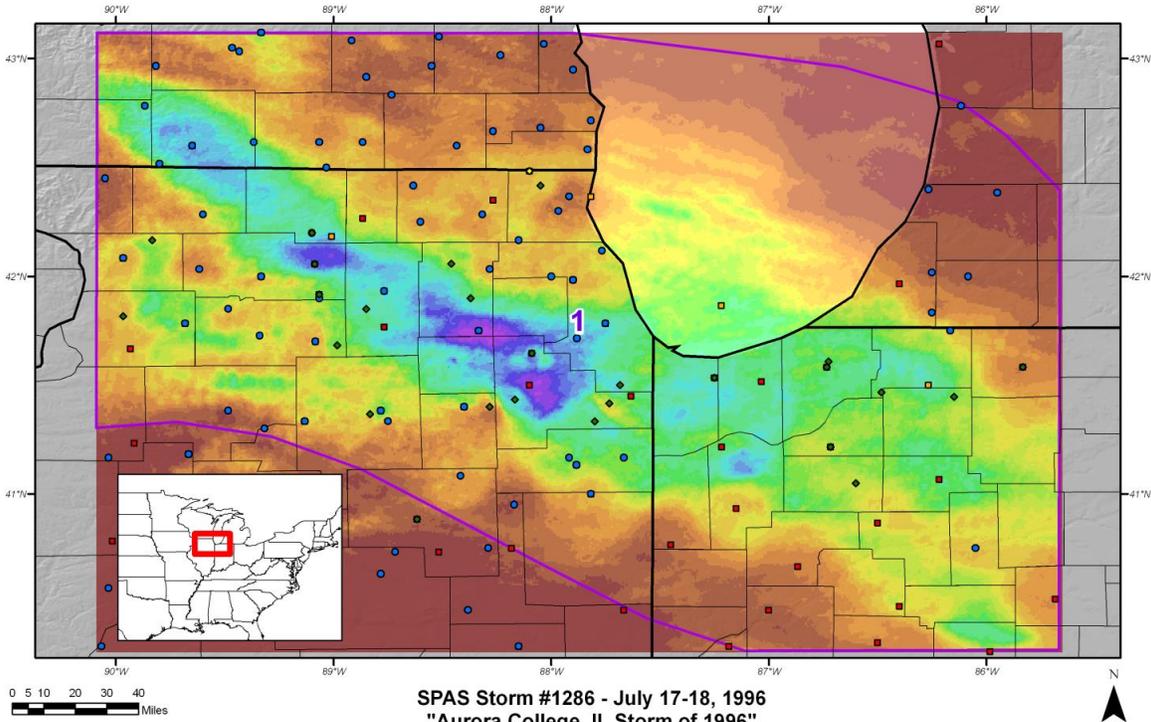
Reliability of Results: With the exception of the Southwestern corner of the analysis domain, we generally have a high degree of confidence in the results. Although there was a good deal of measured daily rainfall amounts in/around the storm center, a lack of hourly data forced us to develop and include several hourly-pseudo stations based on radar data and a default Z-R relationship.

Storm 1286 - July 17 (0100 UTC) - July 19 (0000 UTC), 1996										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	2	3	6	12	18	24	36	48	Total
0.4	6.22	9.20	11.64	14.70	15.68	17.75	18.00	18.06	18.06	18.06
1	6.16	9.14	11.51	14.57	15.55	17.62	17.89	17.92	17.92	17.92
10	5.87	8.60	10.93	13.95	14.97	17.18	17.42	17.43	17.43	17.43
25	5.54	8.13	10.46	13.47	14.46	16.75	16.98	17.00	17.00	17.00
50	5.00	7.70	9.97	13.03	14.02	16.32	16.57	16.59	16.59	16.59
100	4.27	7.11	9.22	12.17	13.39	15.60	16.01	16.04	16.04	16.04
200	3.62	6.32	8.19	10.65	12.53	14.59	15.11	15.16	15.16	15.16
300	3.45	5.79	7.54	9.89	11.85	13.79	14.35	14.42	14.42	14.42
400	3.26	5.41	7.10	9.39	11.36	13.23	13.75	13.86	13.86	13.86
500	3.12	5.14	6.76	9.01	10.97	12.81	13.31	13.39	13.39	13.39
1,000	2.62	4.36	5.74	7.95	9.81	11.37	11.82	11.90	11.90	11.90
2,000	2.17	3.65	4.71	6.72	8.50	9.93	10.36	10.46	10.46	10.46
5,000	1.54	2.61	3.36	4.79	6.45	7.82	8.33	8.49	8.49	8.49
10,000	0.96	1.66	2.29	3.54	5.03	6.25	6.77	6.96	6.97	6.97
20,000	0.53	0.97	1.32	2.19	3.63	4.63	5.11	5.32	5.33	5.33
36,456	0.32	0.57	0.82	1.38	2.33	3.00	3.43	3.61	3.62	3.62



SPAS 1286 Storm Center Mass Curve Zone 1
July 17 (100UTC) to July 19 (0UTC), 1996
Lat: 41.4575 Lon: -88.0699249530957





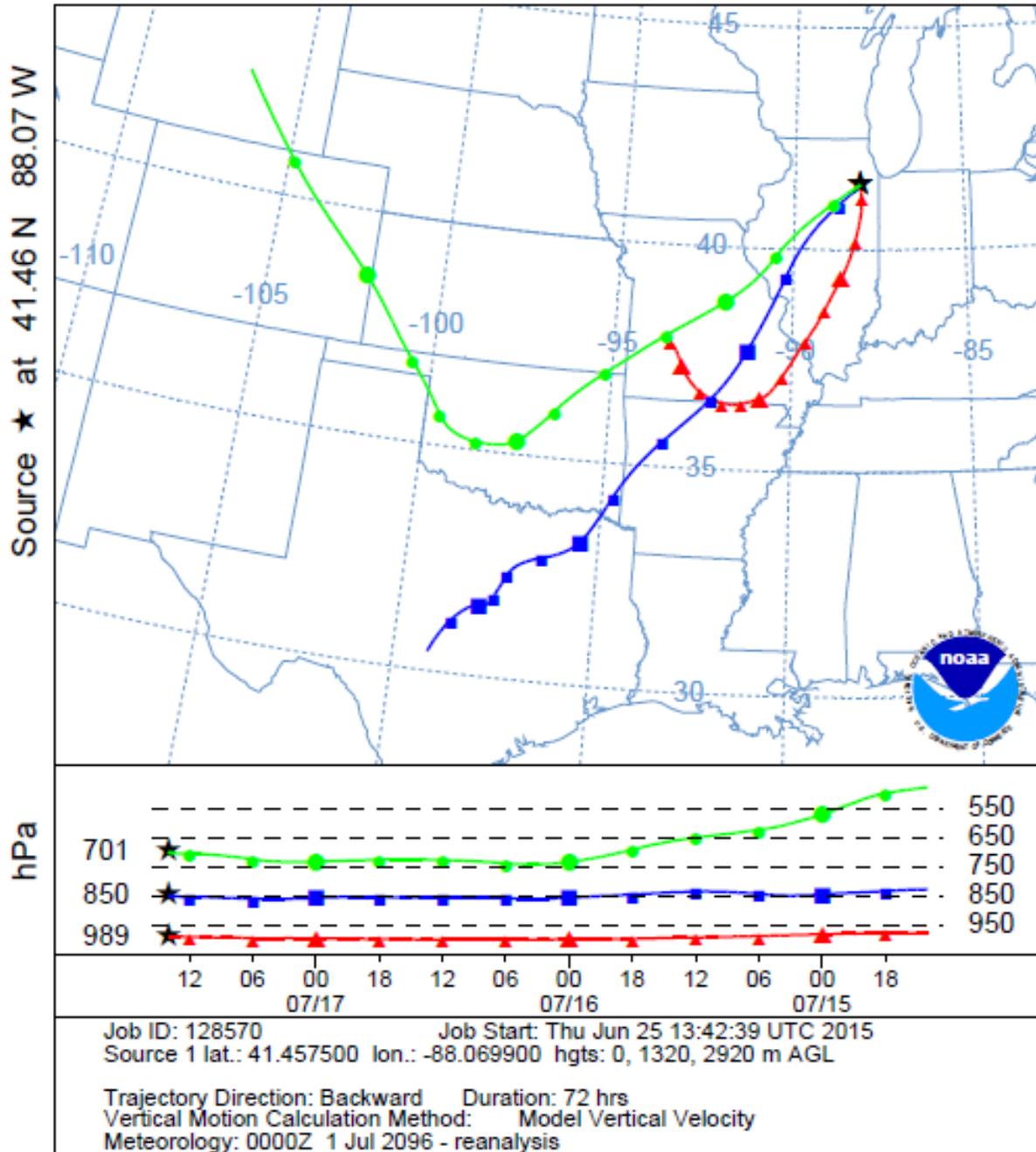
SPAS Storm #1286 - July 17-18, 1996
"Aurora College, IL Storm of 1996"
Total 48-hour Rainfall

July 17, 1996 0100 UTC – July 19, 1996 0000 UTC (48 hours)

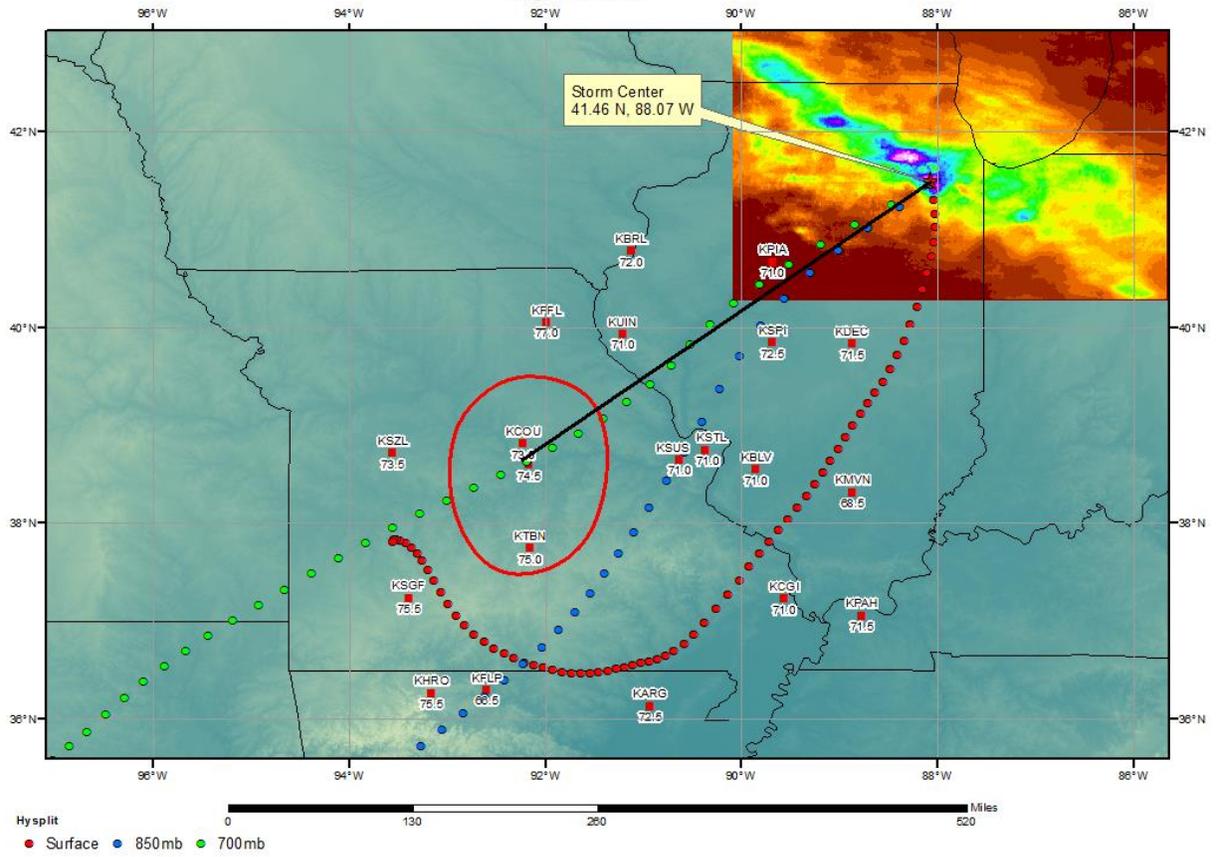


MetStat 05/30/2012

NOAA HYSPLIT MODEL
 Backward trajectories ending at 1400 UTC 17 Jul 96
 CDC1 Meteorological Data



SPAS 1286 Aurora College, IL Storm Analysis July 17, 1996



Storm Precipitation Analysis System (SPAS) For Storm #1228_1 SPAS-NEXRAD Analysis

General Storm Location: Eastern Kansas, Northeastern Oklahoma and western Missouri

Storm Dates: June 26 – July 1, 2007

Event: Mesoscale Convective System (MCS)

DAD Zone 1 (entire domain)

Latitude: 37.63

Longitude: -96.05

Max. Grid Rainfall Amount: 25.50"

Max. Observed Rainfall Amount: 21.40" (FALL RIVER, KS)

Number of Stations: 509 (175 Daily, 68 Hourly, 0 Hourly Estimated, 1 Hourly Estimated Pseudo, 60 Hourly Pseudo, 205 Supplemental, and 0 Supplemental Estimated)

SPAS Version: 9.0

Basemap: PRISM Mean (1971-2000) June precipitation

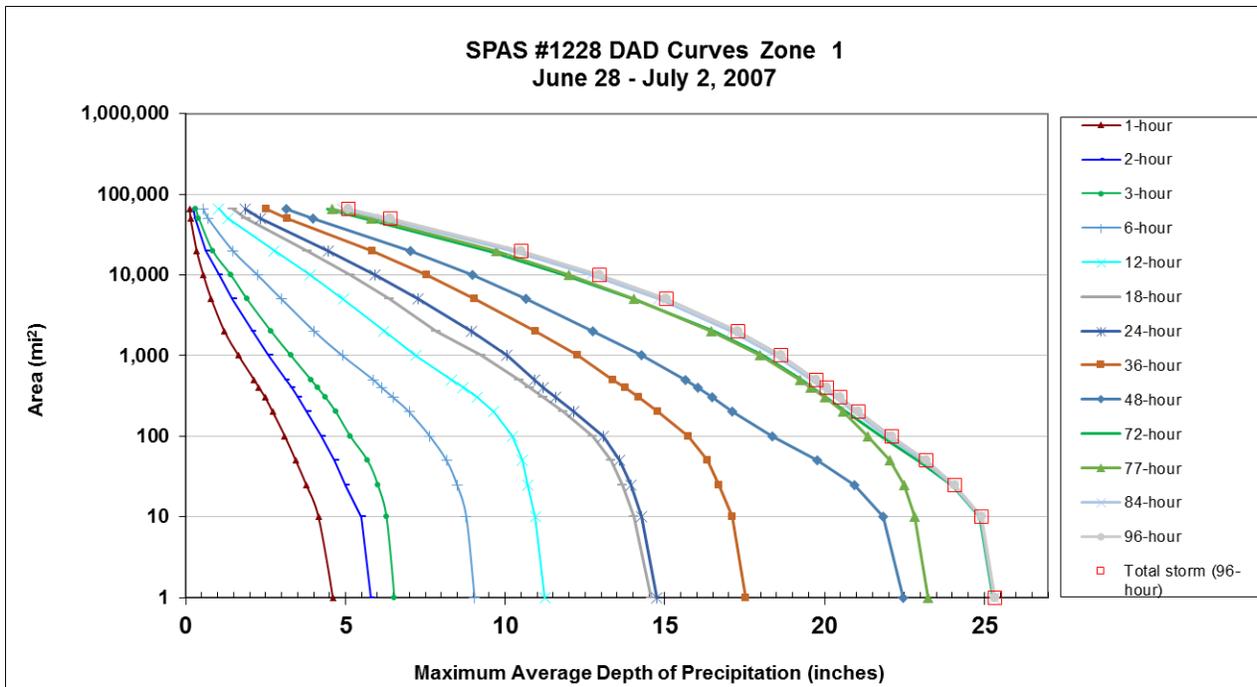
Spatial resolution: 36 seconds (~0.38 mi²)

Radar Included: Yes (no outages)

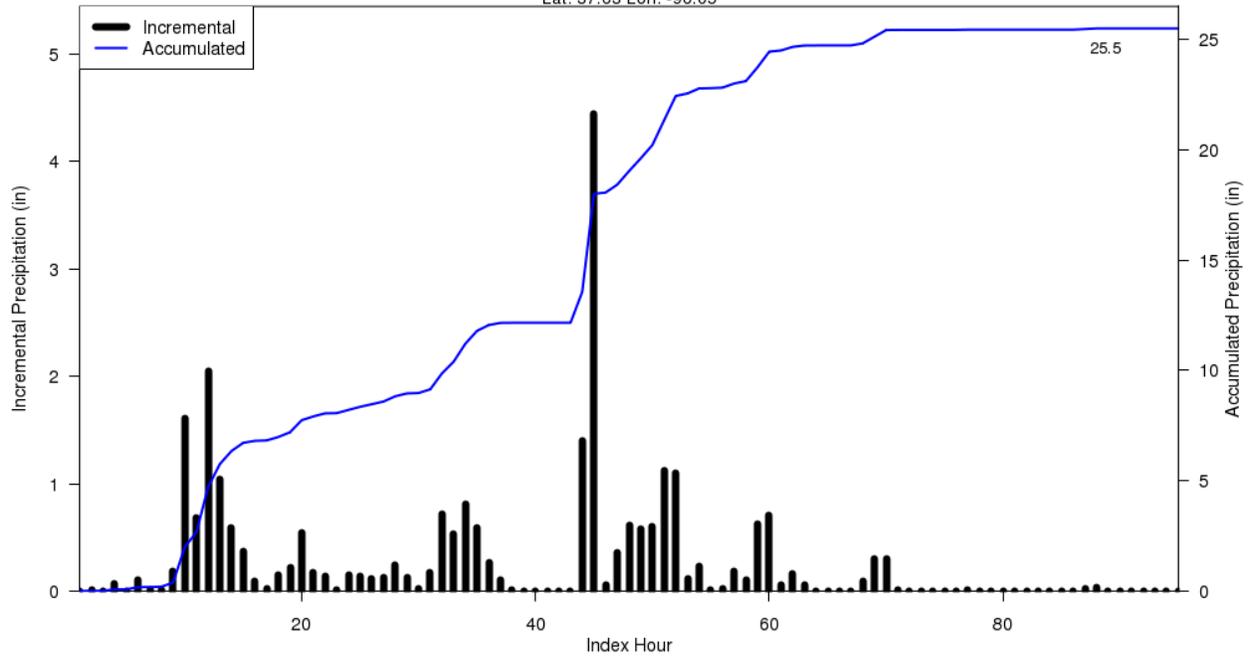
Depth-Area-Duration (DAD) analysis: Yes

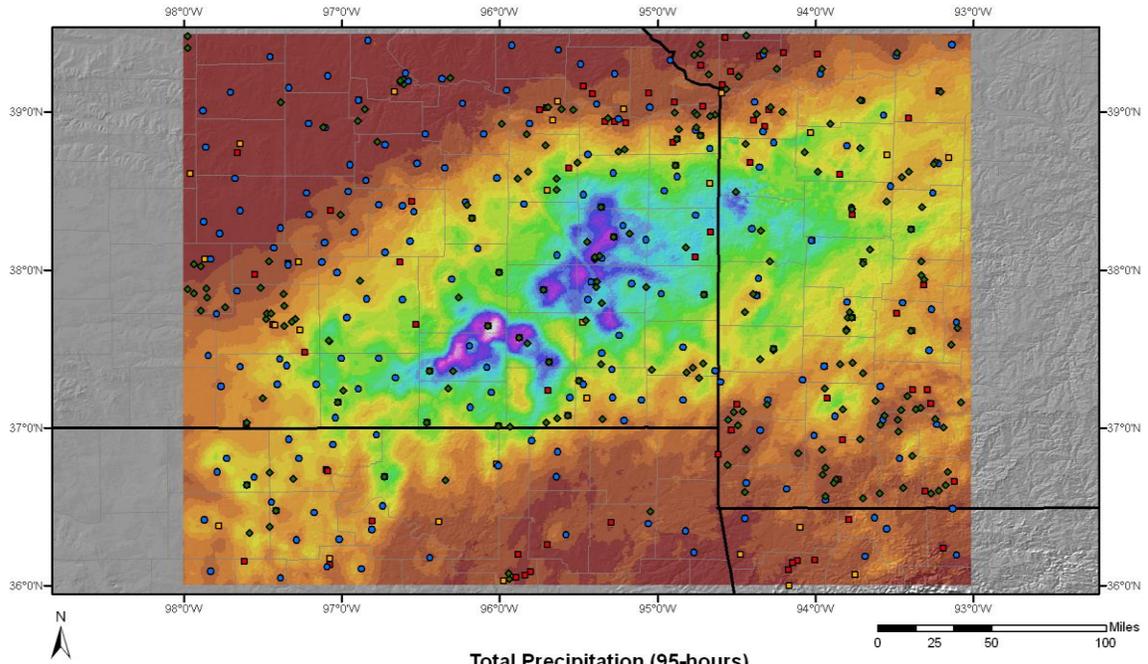
Reliability of results: Given the unblocked, clean and QC'ed radar data coupled with relatively extensive gauge data, we have a very high degree of confidence in the results. No supplemental estimated stations were warranted in this analysis.

Storm 1228 - June 28 (0200 UTC) - July 2 (0000 UTC), 2007														
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)														
Area (mi ²)	Duration (hours)													
	1	2	3	6	12	18	24	36	48	72	77	84	96	Total
0.4	4.68	5.84	6.60	9.12	11.37	14.71	14.90	17.71	22.65	25.42	23.42	25.45	25.49	25.49
1	4.60	5.78	6.53	9.04	11.25	14.57	14.75	17.54	22.47	25.26	23.25	25.29	25.32	25.32
10	4.15	5.50	6.28	8.78	10.95	14.04	14.27	17.11	21.82	24.85	22.83	24.87	24.91	24.91
25	3.77	4.99	6.01	8.49	10.71	13.68	13.93	16.69	20.93	23.99	22.50	24.02	24.08	24.08
50	3.44	4.66	5.69	8.16	10.54	13.31	13.59	16.33	19.77	22.91	22.03	23.05	23.17	23.17
100	3.10	4.24	5.15	7.64	10.23	12.75	13.06	15.74	18.37	21.76	21.37	21.95	22.10	22.10
200	2.72	3.80	4.70	6.99	9.65	11.82	12.15	14.78	17.12	20.66	20.57	20.91	21.07	21.07
300	2.49	3.52	4.38	6.50	9.14	11.19	11.58	14.17	16.48	20.05	20.02	20.33	20.48	20.48
400	2.29	3.30	4.12	6.13	8.68	10.77	11.19	13.75	16.04	19.63	19.57	19.92	20.07	20.07
500	2.14	3.13	3.92	5.87	8.32	10.44	10.91	13.38	15.64	19.29	19.23	19.60	19.75	19.75
1,000	1.65	2.60	3.29	4.90	7.21	9.25	10.04	12.26	14.27	18.06	17.99	18.47	18.64	18.64
2,000	1.21	2.08	2.67	4.02	6.20	7.85	8.94	10.95	12.76	16.53	16.46	17.08	17.30	17.30
5,000	0.80	1.46	1.92	3.00	4.94	6.38	7.26	9.04	10.64	14.00	14.03	14.81	15.06	15.06
10,000	0.55	1.03	1.41	2.24	3.89	5.16	5.93	7.53	8.97	11.85	11.99	12.68	12.94	12.94
20,000	0.34	0.63	0.84	1.47	2.77	3.80	4.46	5.83	7.04	9.49	9.72	10.24	10.50	10.50
50,000	0.15	0.29	0.41	0.70	1.32	1.90	2.33	3.18	3.98	5.59	5.80	6.17	6.40	6.40
65,762	0.12	0.23	0.31	0.55	1.03	1.48	1.87	2.51	3.15	4.44	4.59	4.91	5.10	5.10



SPAS 1228 Storm Center Mass Curve Zone 1
June 28 (200UTC) to July 2 (0UTC), 2007
Lat: 37.63 Lon: -96.05

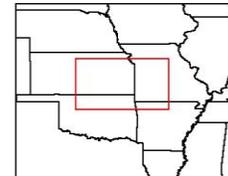




Total Precipitation (95-hours)
SPAS #1228
06/28/2007 0200 UTC - 07/02/2007 0000 UTC

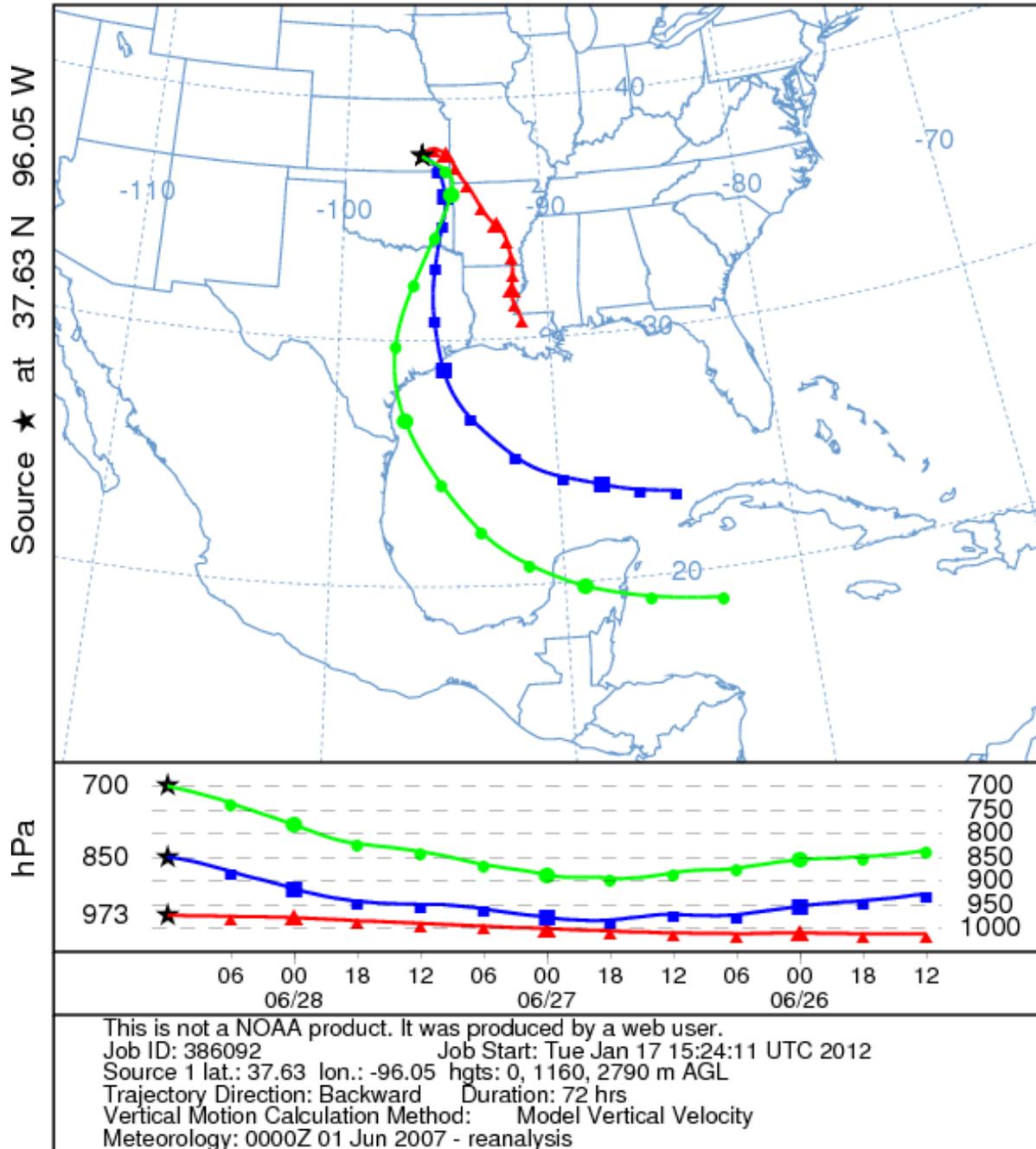
Precipitation (inches)

0.00 - 1.00	5.01 - 6.00	10.01 - 11.00	15.01 - 16.00	20.01 - 21.00	• Daily
1.01 - 2.00	6.01 - 7.00	11.01 - 12.00	16.01 - 17.00	21.01 - 22.00	■ Hourly
2.01 - 3.00	7.01 - 8.00	12.01 - 13.00	17.01 - 18.00	22.01 - 23.00	■ Hourly Est. Pseudo
3.01 - 4.00	8.01 - 9.00	13.01 - 14.00	18.01 - 19.00	23.01 - 24.00	■ Hourly Pseudo
4.01 - 5.00	9.01 - 10.00	14.01 - 15.00	19.01 - 20.00	24.01 - 25.00	◆ Supplemental



01/11/2012

NOAA HYSPLIT MODEL
 Backward trajectories ending at 1200 UTC 28 Jun 07
 CDC1 Meteorological Data



Storm Precipitation Analysis System (SPAS) For Storm #1296_1 SPAS-NEXRAD Analysis

General Storm Location: Duluth, Minnesota

Storm Dates: June 19-21, 2012

Event: MCC, Flash Flood Event

DAD Zone 1

Latitude: 47.015

Longitude: -91.665

Max. Grid Rainfall Amount: 10.73"

Max. Observed Rainfall Amount: 10.71"

Number of Stations: 405 (83 Daily, 102 Hourly, 31 Hourly Pseudo, and 189 Supplemental)

SPAS Version: 9.5

Basemap: PRISM June 2012 Precipitation

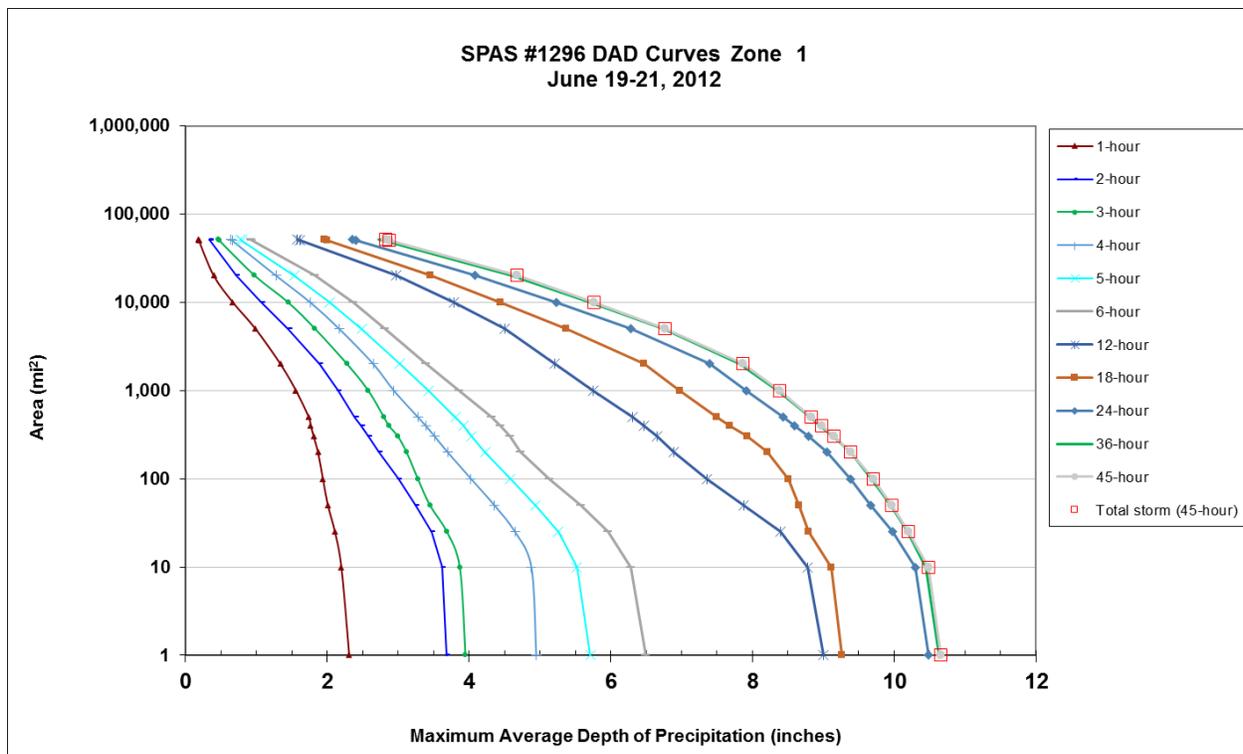
Spatial resolution: 0.01 (~ 0.40 mi²)

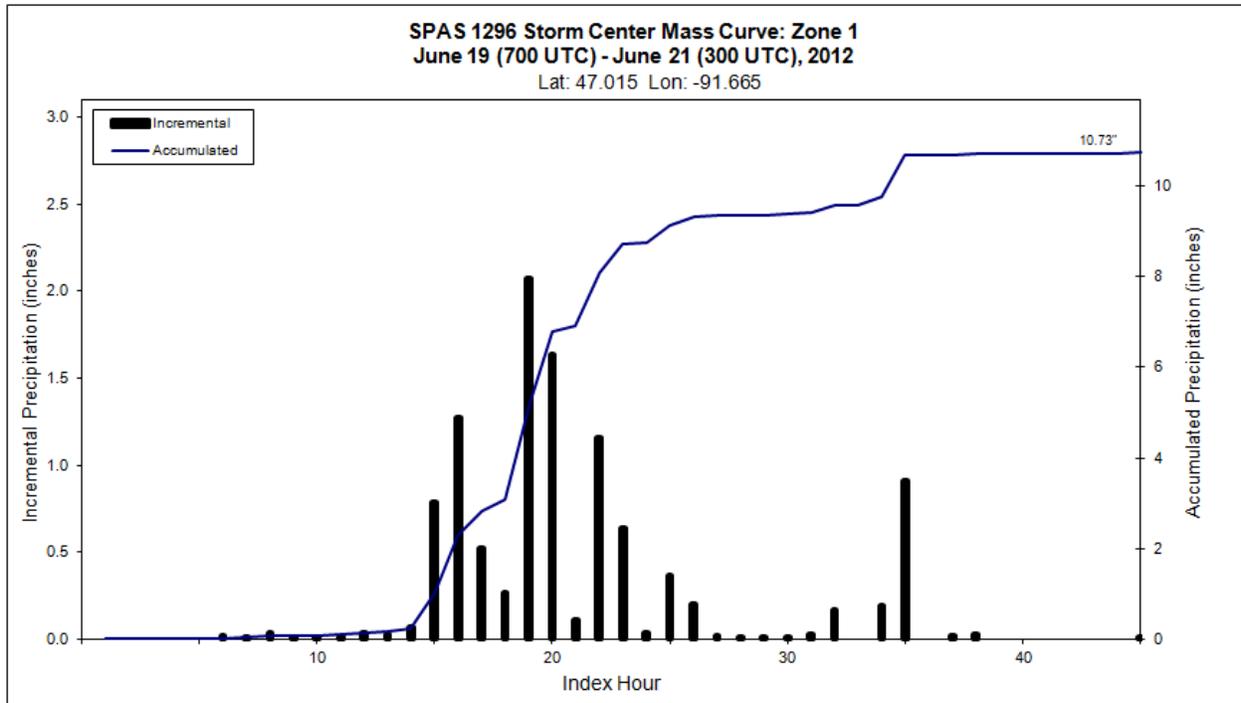
Radar Included: Yes

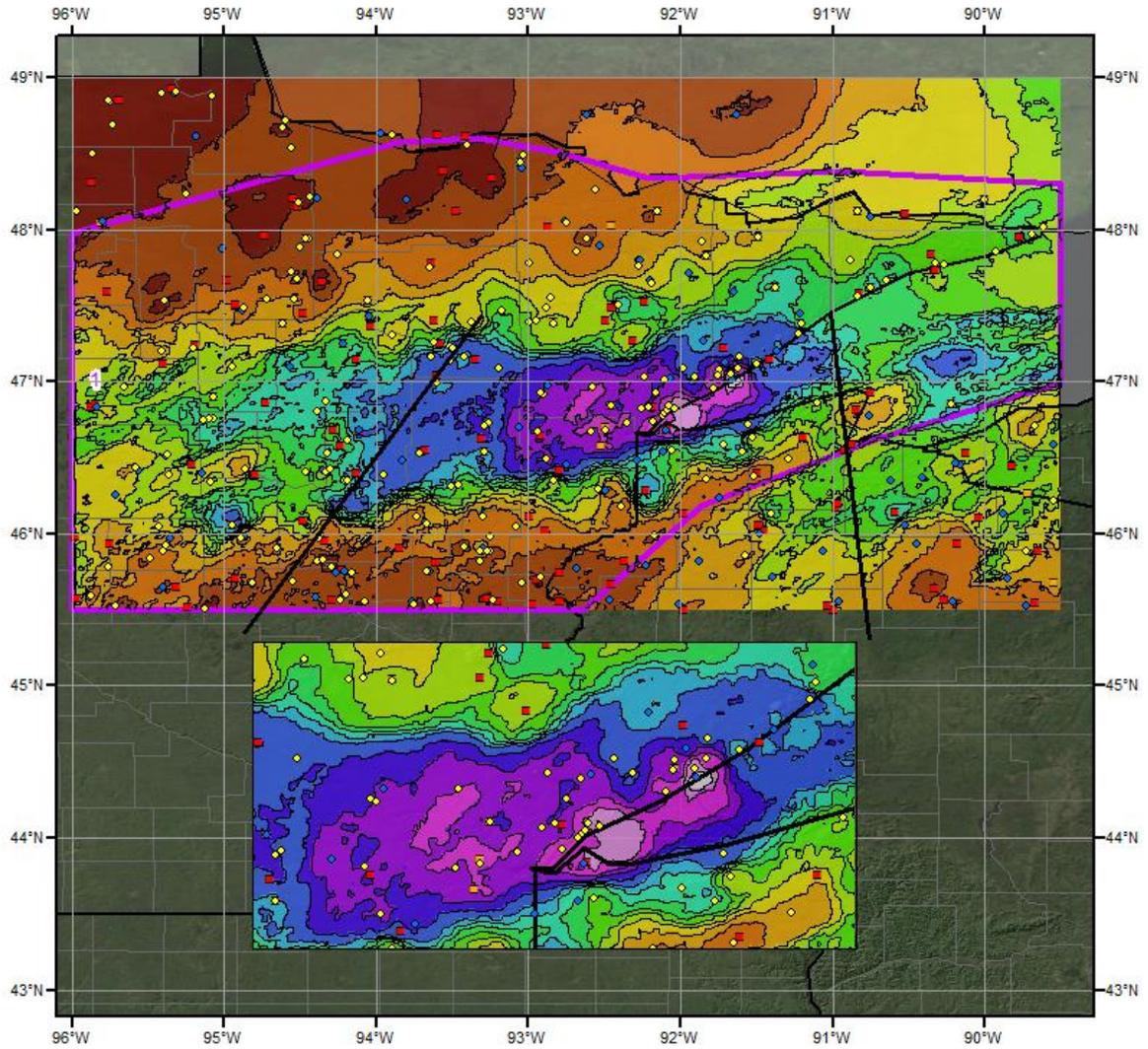
Depth-Area-Duration (DAD) analysis: Yes

Reliability of results: This analysis was based on hourly data, daily data, supplemental station data and NEXRAD Radar. We have a high degree of confidence in the radar/station based storm total results, the spatial pattern is dependent on the radar data and basemap, and the timing is based on hourly and hourly pseudo stations.

Storm 1296 - June 19 (0700 UTC) - June 21 (0300 UTC), 2012												
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)												
Area (mi ²)	Duration (hours)											
	1	2	3	4	5	6	12	18	24	36	45	Total
0.4	2.34	3.71	3.97	4.98	5.76	6.55	9.07	9.32	10.55	10.70	10.72	10.72
1	2.31	3.68	3.95	4.95	5.71	6.49	9.00	9.26	10.48	10.63	10.65	10.65
10	2.20	3.62	3.87	4.88	5.52	6.28	8.78	9.11	10.30	10.44	10.48	10.48
25	2.11	3.47	3.69	4.65	5.26	5.96	8.39	8.79	9.97	10.19	10.20	10.20
50	2.01	3.25	3.45	4.36	4.94	5.58	7.88	8.65	9.67	9.95	9.96	9.96
100	1.94	3.00	3.28	4.03	4.58	5.13	7.36	8.51	9.38	9.68	9.70	9.70
200	1.87	2.73	3.12	3.70	4.23	4.73	6.89	8.21	9.05	9.38	9.38	9.38
300	1.81	2.58	3.00	3.52	4.04	4.58	6.65	7.92	8.79	9.14	9.15	9.15
400	1.77	2.48	2.87	3.39	3.92	4.44	6.47	7.68	8.59	8.95	8.97	8.97
500	1.74	2.39	2.80	3.28	3.81	4.32	6.31	7.50	8.43	8.81	8.83	8.83
1,000	1.56	2.15	2.58	2.94	3.43	3.86	5.75	6.98	7.91	8.36	8.38	8.38
2,000	1.34	1.89	2.28	2.65	3.03	3.40	5.21	6.47	7.39	7.82	7.87	7.87
5,000	0.99	1.45	1.83	2.17	2.49	2.82	4.50	5.37	6.28	6.74	6.76	6.76
10,000	0.67	1.07	1.45	1.76	2.03	2.37	3.79	4.44	5.24	5.71	5.77	5.77
20,000	0.40	0.72	0.98	1.28	1.54	1.83	2.98	3.46	4.08	4.59	4.68	4.68
50,000	0.19	0.35	0.48	0.66	0.80	0.94	1.62	2.00	2.41	2.79	2.88	2.88
51,309	0.18	0.34	0.47	0.64	0.78	0.92	1.58	1.96	2.36	2.73	2.83	2.83







**Total Storm (45-hr) Precipitation (inches)
 June 19 (0700 UTC) - 21 (0300), 2012
 SPAS-NEXRAD 1296**

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental



Precipitation (inches)

0.00 - 0.50	2.01 - 2.50	4.01 - 4.50	7.01 - 8.00
0.51 - 1.00	2.51 - 3.00	4.51 - 5.00	8.01 - 9.00
1.01 - 1.50	3.01 - 3.50	5.01 - 6.00	9.01 - 10.00
1.51 - 2.00	3.51 - 4.00	6.01 - 7.00	10.01 - 11.00

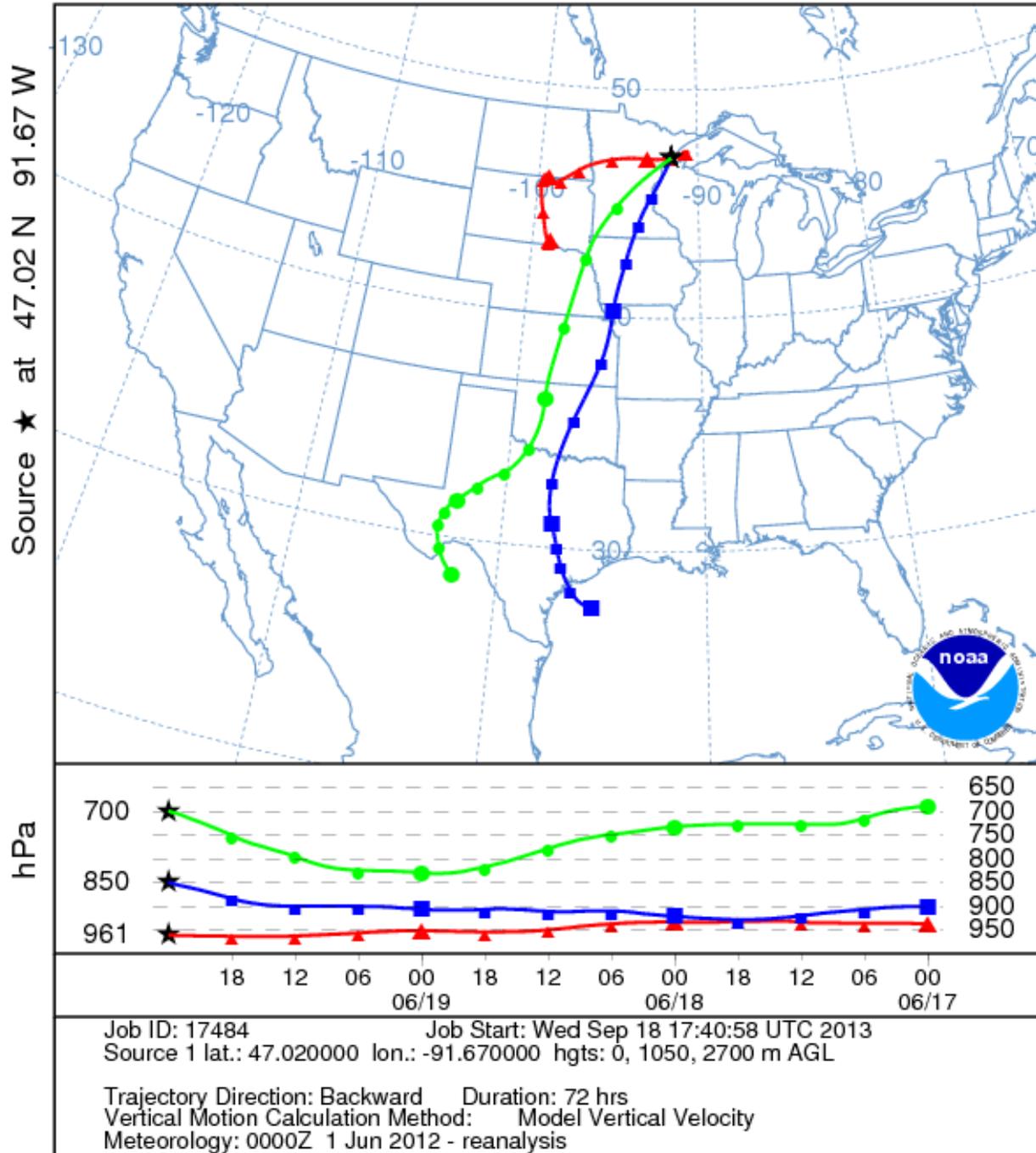


9/18/2013

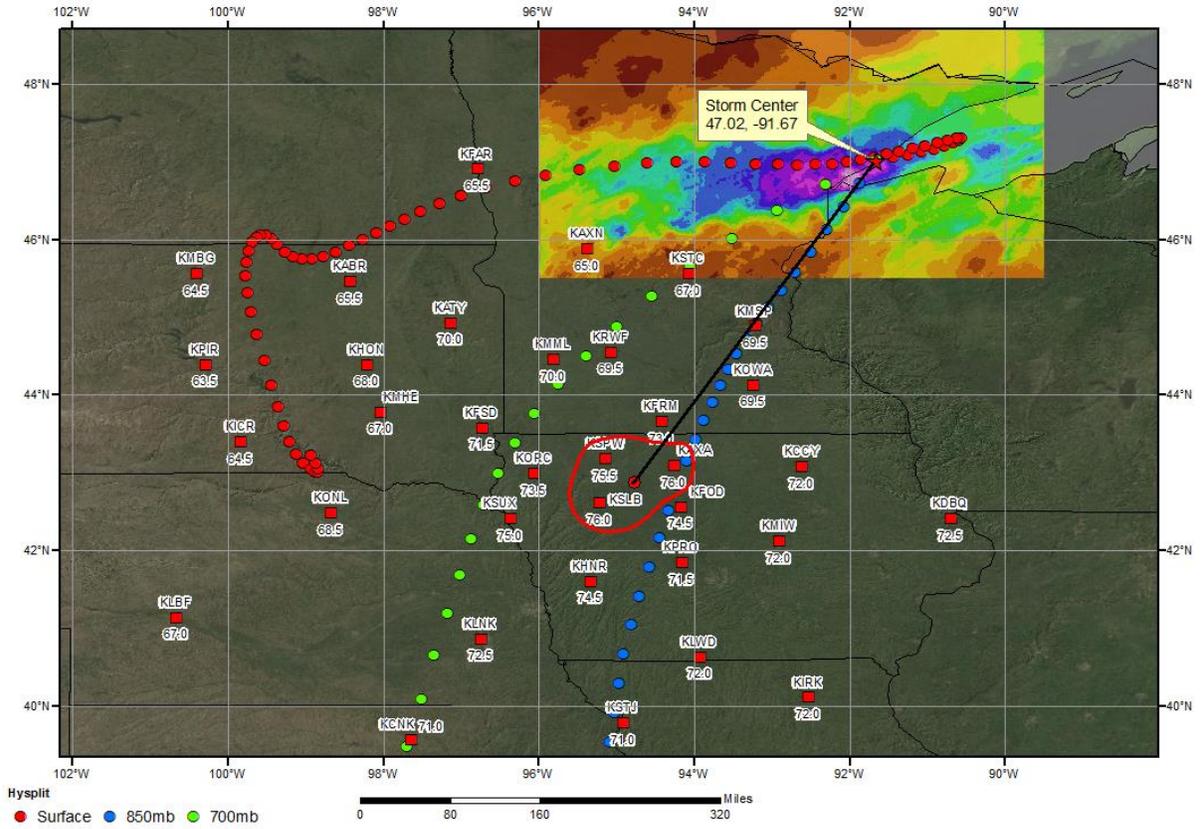
NOAA HYSPLIT MODEL

Backward trajectories ending at 0000 UTC 20 Jun 12

CDC1 Meteorological Data



SPAS 1296 Duluth, MN Storm Analysis June 17--20, 2012



Local Storms

Storm Precipitation Analysis System (SPAS) For Storm #1426_1 SPAS Analysis

General Storm Location: Cooper, MI

Storm Dates: September 1 – September 2, 1914

Event: Extreme Precipitation Event

DAD Zone 1

Latitude: 42.3708

Longitude: -85.5875

Max. Grid Rainfall Amount: 13.39"

Max. Observed Rainfall Amount: 12.80"

Number of Stations: 30

SPAS Version: 10.0

Base Map Used: Continental United States 2 year 6 hour (conus_0002yr06h)

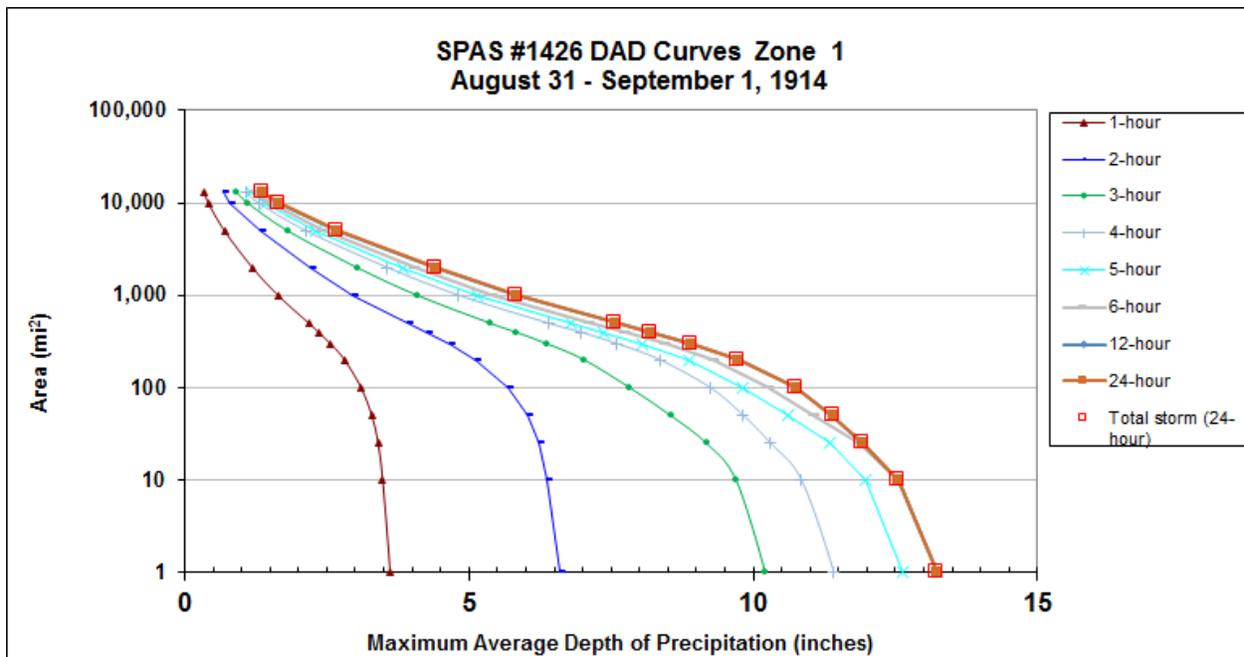
Spatial resolution: 0.2451

Radar Included: No

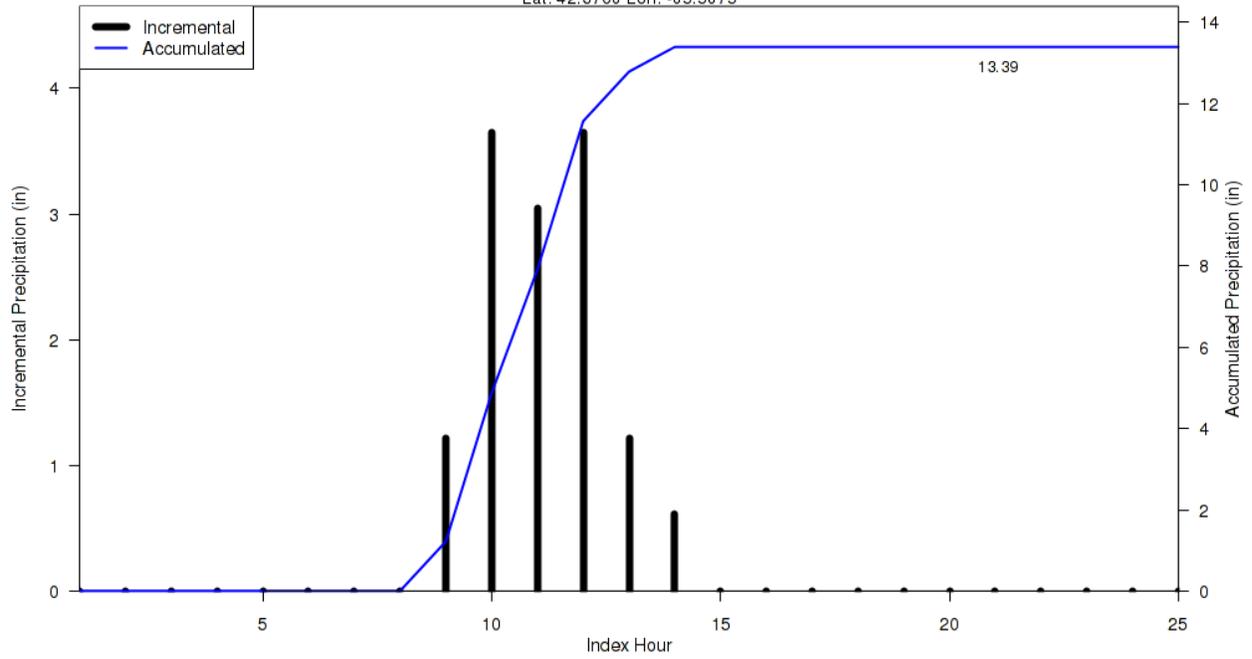
Depth-Area-Duration (DAD) analysis: Yes

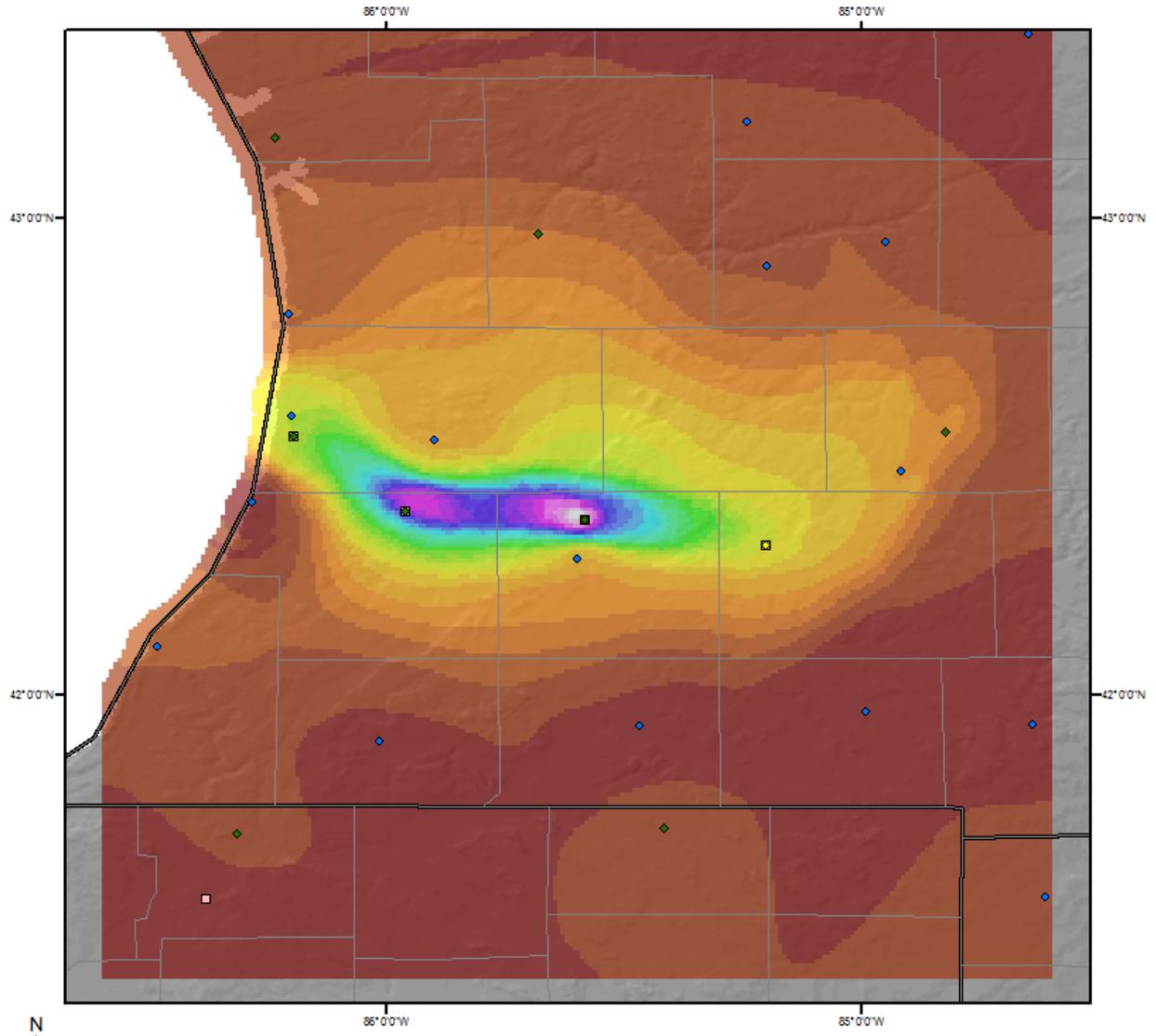
Reliability of results: In addition to the NCDC stations, three hourly stations were digitized from the U.S. Army Corp of Engineers (USACE) Storm Study Pertinent Data Sheet (included below). These stations only provided precipitation timing for the time period beginning on August 31, 1914 at 6pm EST and ending at 6pm the following day. Due to the lack of hourly information, a 25-hour Core Precipitation Period (CPP) was established for this time period. While precipitation did fall outside of the CPP, results are unreliable due to the lack of data. The resulting DAD values are slightly less than those determined by the initial USACE report. Major adjustments were completed in order to simulate USACE results, however the original analysis likely over generalized the storm area and this analysis likely provides a more accurate depiction of the event.

Storm 1426 - August 31 (0000 UTC) - September 1 (0000 UTC), 1914									
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)									
Area (mi ²)	Duration (hours)								
	1	2	3	4	5	6	12	24	Total
0.4	3.64	6.66	10.30	11.51	12.73	13.33	13.33	13.33	13.33
1	3.61	6.61	10.21	11.41	12.62	13.23	13.23	13.23	13.23
10	3.48	6.38	9.70	10.84	11.98	12.55	12.55	12.55	12.55
25	3.40	6.23	9.18	10.30	11.34	11.88	11.93	11.93	11.93
50	3.29	6.02	8.55	9.82	10.61	11.07	11.40	11.40	11.40
100	3.10	5.68	7.83	9.24	9.82	10.26	10.74	10.75	10.75
200	2.81	5.13	7.03	8.36	8.87	9.29	9.74	9.74	9.74
300	2.56	4.67	6.37	7.60	8.06	8.45	8.88	8.89	8.89
400	2.35	4.27	5.82	6.96	7.37	7.74	8.17	8.18	8.18
500	2.18	3.93	5.37	6.39	6.79	7.11	7.58	7.58	7.58
1,000	1.64	2.97	4.09	4.82	5.16	5.40	5.83	5.84	5.84
2,000	1.19	2.23	3.03	3.56	3.83	4.04	4.40	4.41	4.41
5,000	0.70	1.33	1.81	2.13	2.30	2.43	2.67	2.68	2.68
10,000	0.42	0.81	1.11	1.30	1.41	1.49	1.64	1.65	1.65
12,928	0.35	0.68	0.92	1.09	1.18	1.24	1.37	1.37	1.37



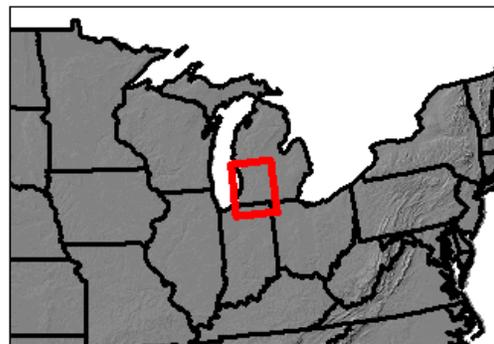
SPAS 1426 Storm Center Mass Curve Zone 1
August 31 (0000UTC) to September 1 (0000UTC), 1914
Lat: 42.3708 Lon: -85.5875





Total 25-hour Precipitation (inches)
September 1, 1914 0000 UTC - September 2, 1914 0500 UTC
SPAS #1426

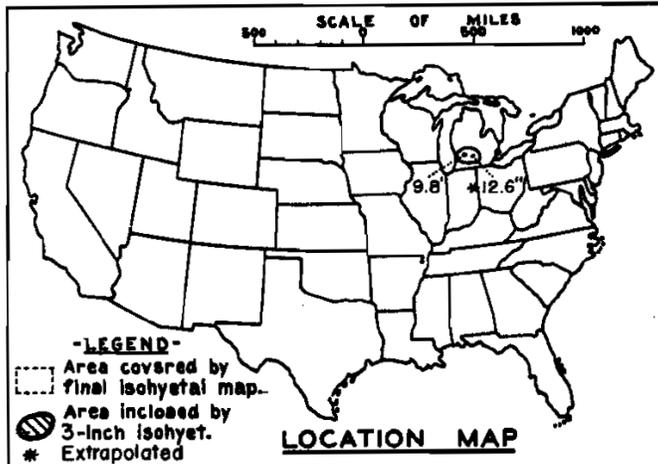
Stations	Precipitation (inches)		
◆ D	0.00 - 0.50	4.51 - 5.00	9.01 - 9.50
□ HE	0.51 - 1.00	5.01 - 5.50	9.51 - 10.00
■ HEP	1.01 - 1.50	5.51 - 6.00	10.01 - 10.50
◆ S	1.51 - 2.00	6.01 - 6.50	10.51 - 11.00
◆ SE	2.01 - 2.50	6.51 - 7.00	11.01 - 11.50
	2.51 - 3.00	7.01 - 7.50	11.51 - 12.00
	3.01 - 3.50	7.51 - 8.00	12.01 - 12.50
	3.51 - 4.00	8.01 - 8.50	12.51 - 13.00
	4.01 - 4.50	8.51 - 9.00	13.01 - 13.50



WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

STORM STUDIES - PERTINENT DATA SHEET



Storm of 31 Aug.-1 Sept. 1914
 Assignment GL 2-16
 Location Michigan
 Study Prepared by:
 Great Lakes Division
 Milwaukee District Office and
 Hydrometeorological Section of
 U. S. Weather Bureau.
 Part I Reviewed by H. M. Sec. of
 Weather Bureau, 10/26/39
 Part II Approved by Office, Chief
 of Engineers for Distribution
 of Factual Data, 10/26/46
 Remarks: Centers near
 Cooper and Bloomingdale,
 Mich.

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary Isohyetal map, in 1 sheet, scale 1 : 2,500,000
 Precipitation data and mass curves: (Number of Sheets)
 Form 5001-C (Hourly precip. data)----- 8
 Form 5001-B (24-hour " ")----- 5
 Form 5001-D (" " " ")----- -
 Misc. precip. records, meteorological data, etc.----- 6
 Form 5002 (Mass rainfall curves)----- 4

PART II

Final isohyetal maps, in 1 sheet, scale 1 : 1,000,000
 Data and computation sheets:
 Form S-10 (Data from mass rainfall curves)----- 2
 Form S-11 (Depth-area data from isohyetal map)----- -
 Form S-12 (Maximum depth-duration data)----- -
 Maximum duration-depth-area curves----- 1
 Data relating to periods of maximum rainfall----- -

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6									
10	12.6									
50	12.0									
100	11.3									
200	10.0									
500	7.6									
800	6.3									
1,000	5.7									
1,200	5.2									

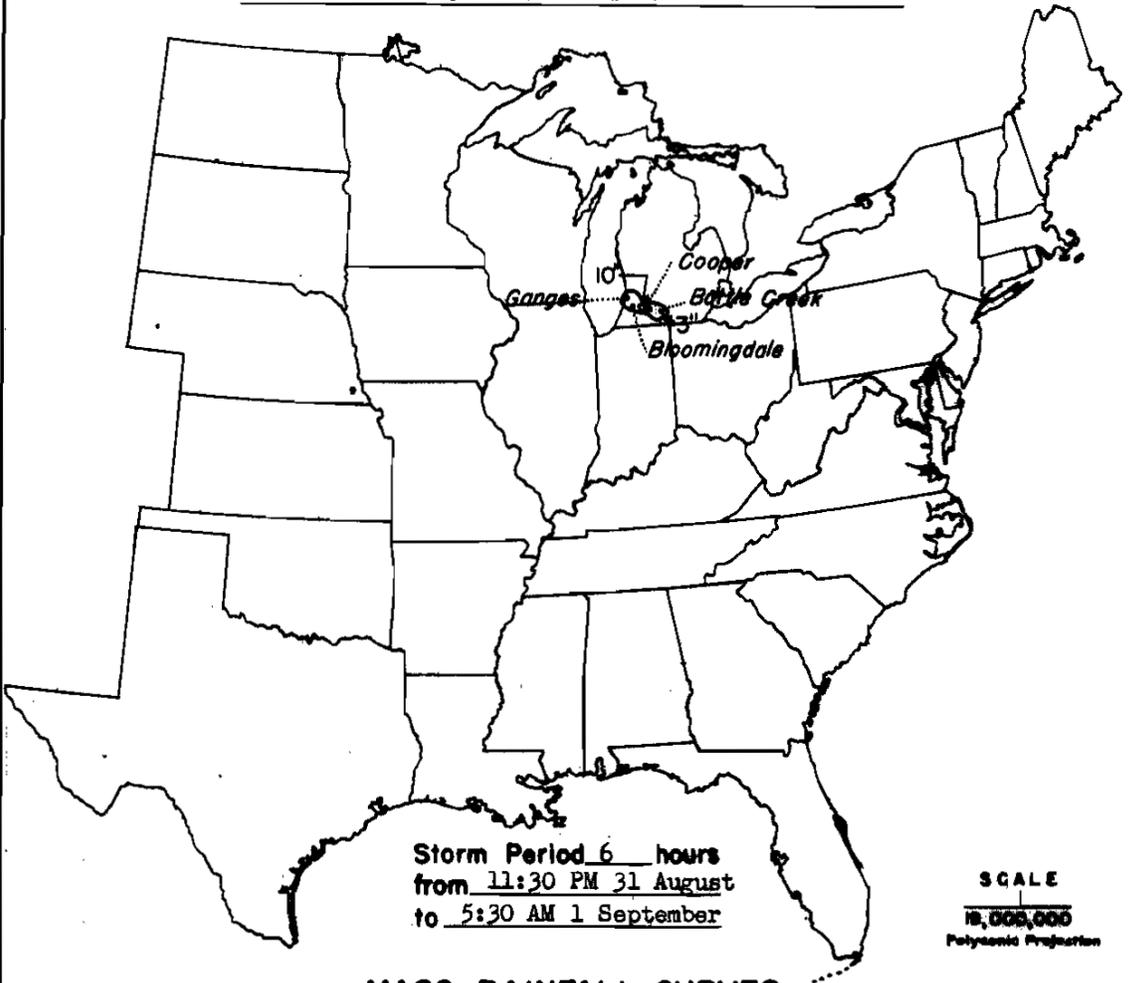
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

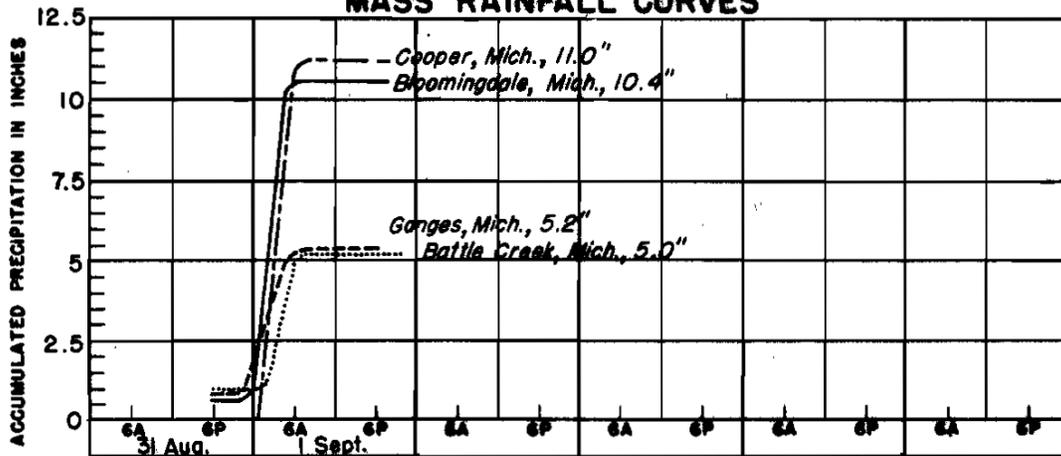
STORM STUDIES - ISOHYETAL MAP

Storm of Aug. 31-Sept. 1, 1914 Assignment GL 2-16

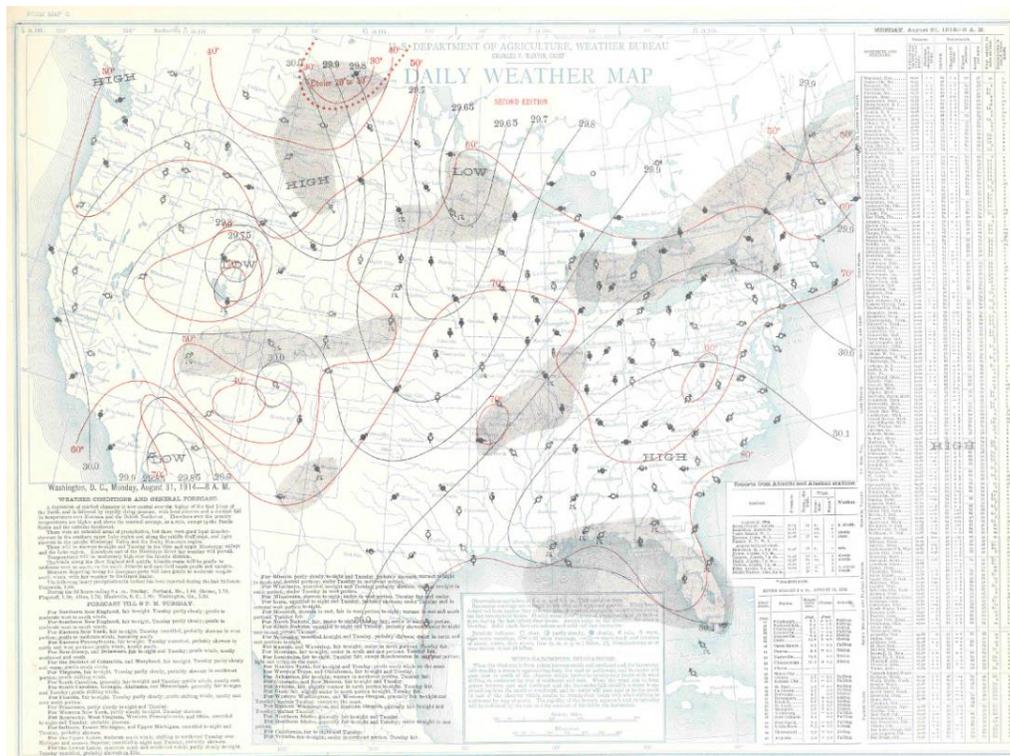
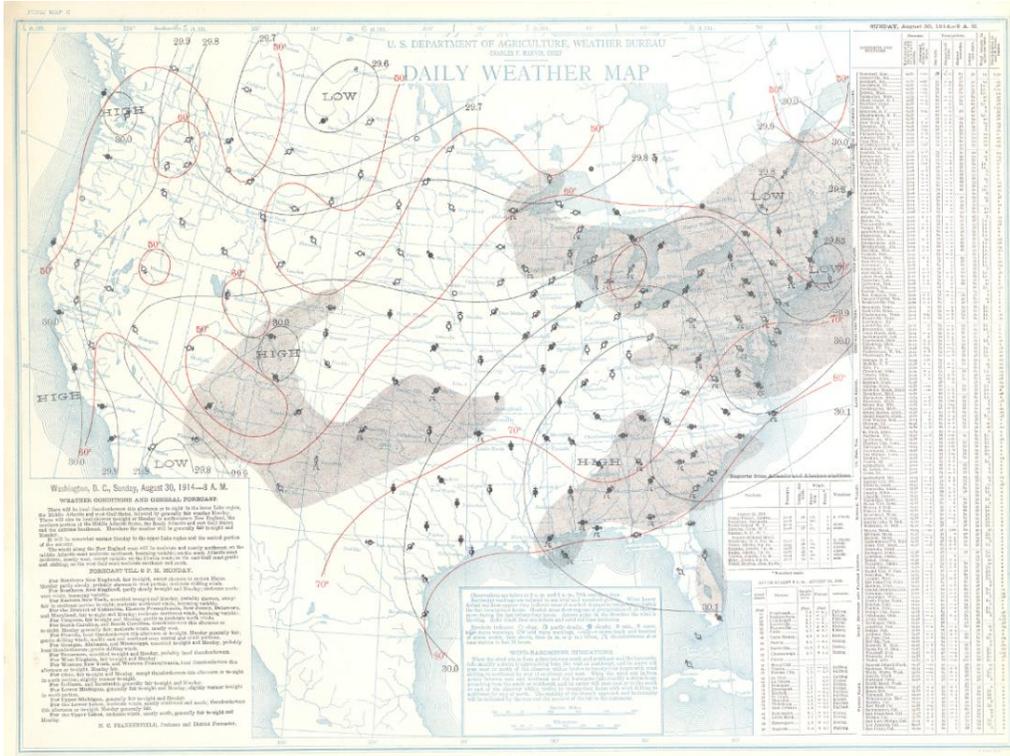
Study Prepared by: Milwaukee, Wisc. District
Great Lakes Division

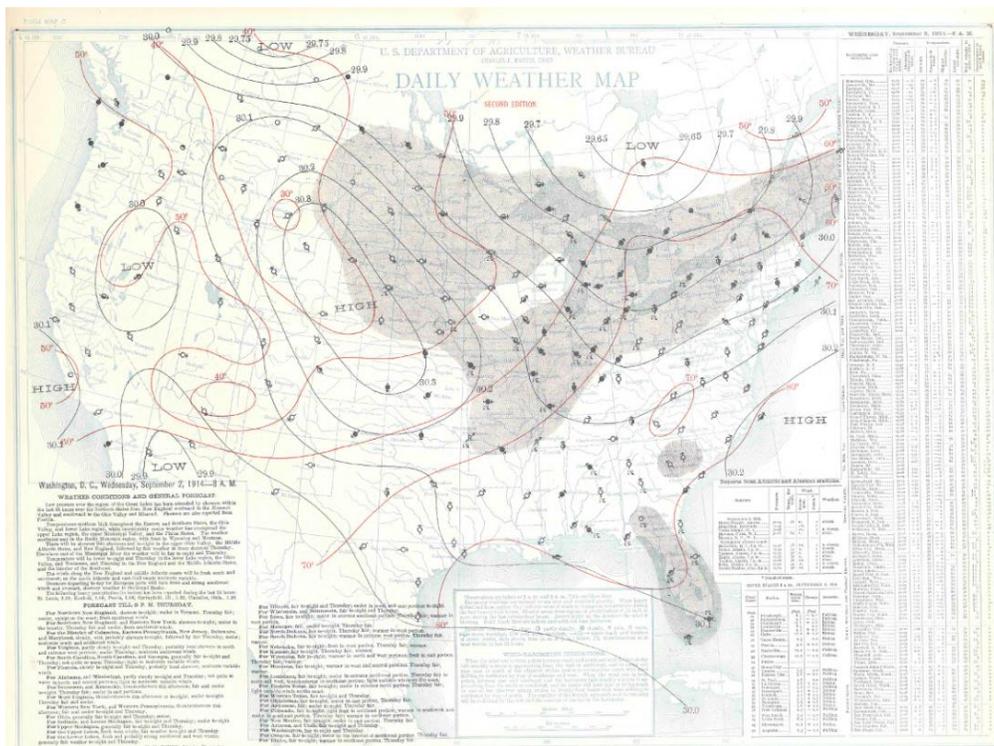
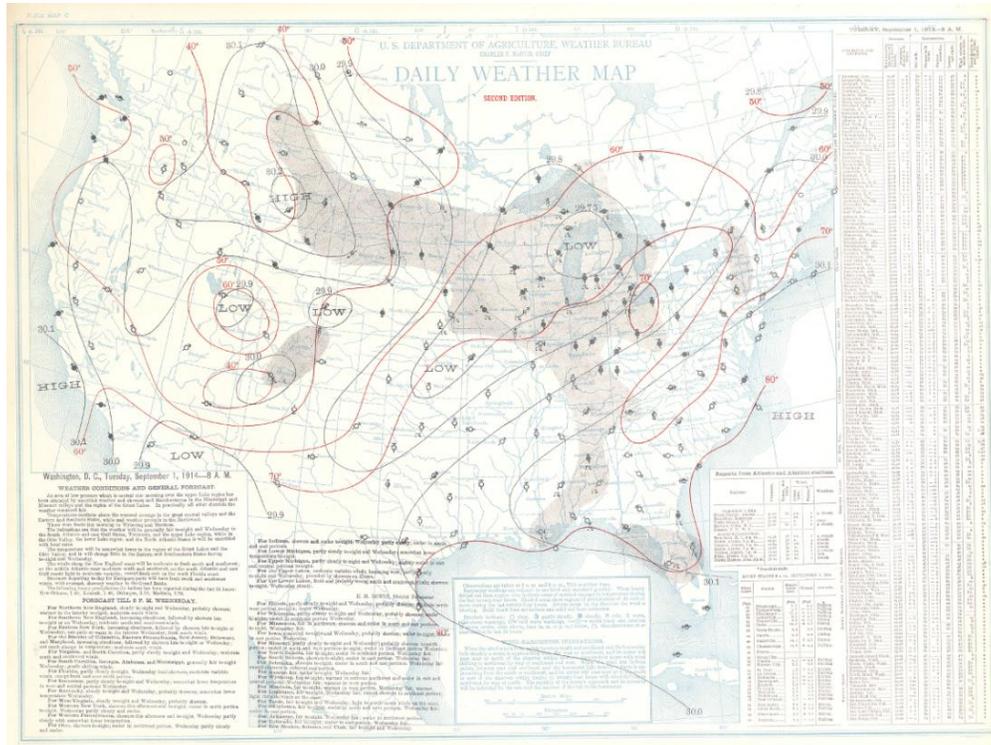


MASS RAINFALL CURVES



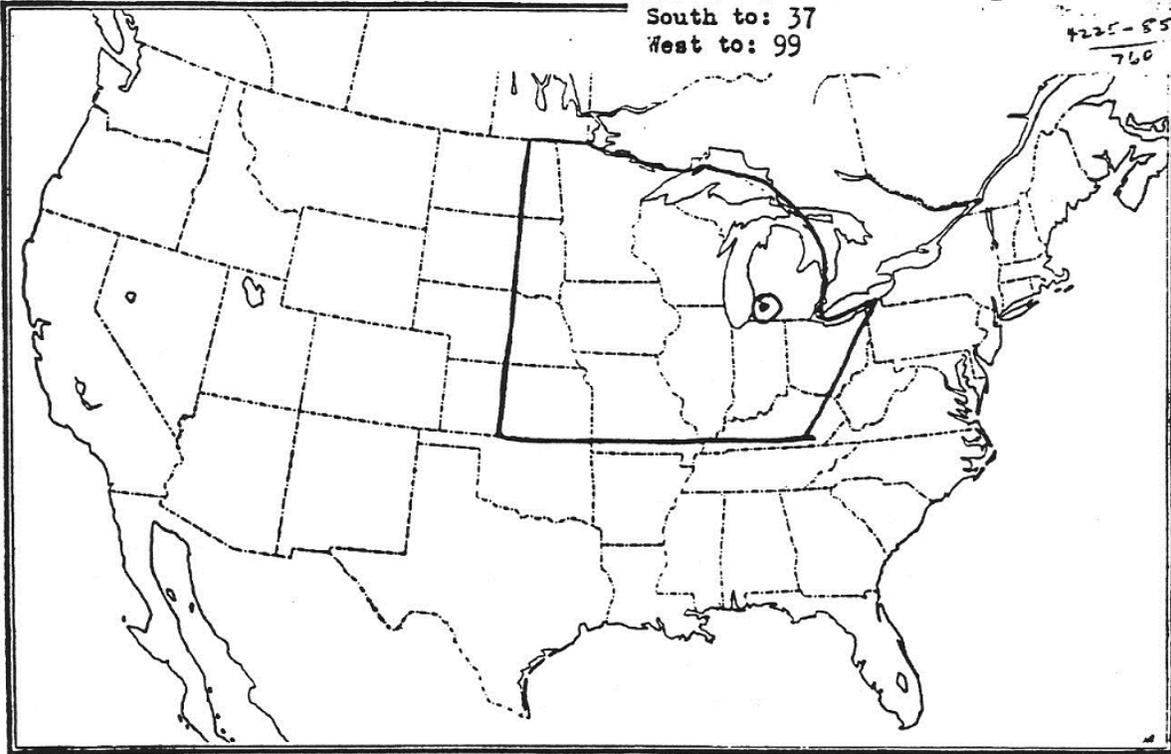
FORM 8-3E





GL 2-16..Aug.31-Sept.1, 1914..Cooper, L
12-hr. rTd 68..250 SW..~~74~~ 77.55%
North to: border
East to: Erie-Chattanooga line
South to: 37
West to: 99

425-853
760



Storm Precipitation Analysis System (SPAS) For Storm #1521_2 SPAS Analysis

General Storm Location: Bassano, Alberta

Storm Dates: May 29 - June 2, 1923

Event: Synoptic/Convective Event

DAD Zone 1

Latitude: 50.4375°

Longitude: -114.3042°

Max. Grid Rainfall Amount: 167mm

Max. Observed Rainfall Amount: 171mm

DAD Zone 2

Latitude: 50.7792°

Longitude: -112.5708°

Max. Grid Rainfall Amount: 196mm

Max. Observed Rainfall Amount: 191mm

Number of Stations: 90 (65 Daily, 1 Hourly, 2 Hourly Pseudo, 0 Hourly Estimated Pseudo, and 22 Supplemental)

SPAS Version: 10.0

Basemap: Blended PRISM July 1961-1990 Climatology (Canada) and AL 5-23 Isohyetal

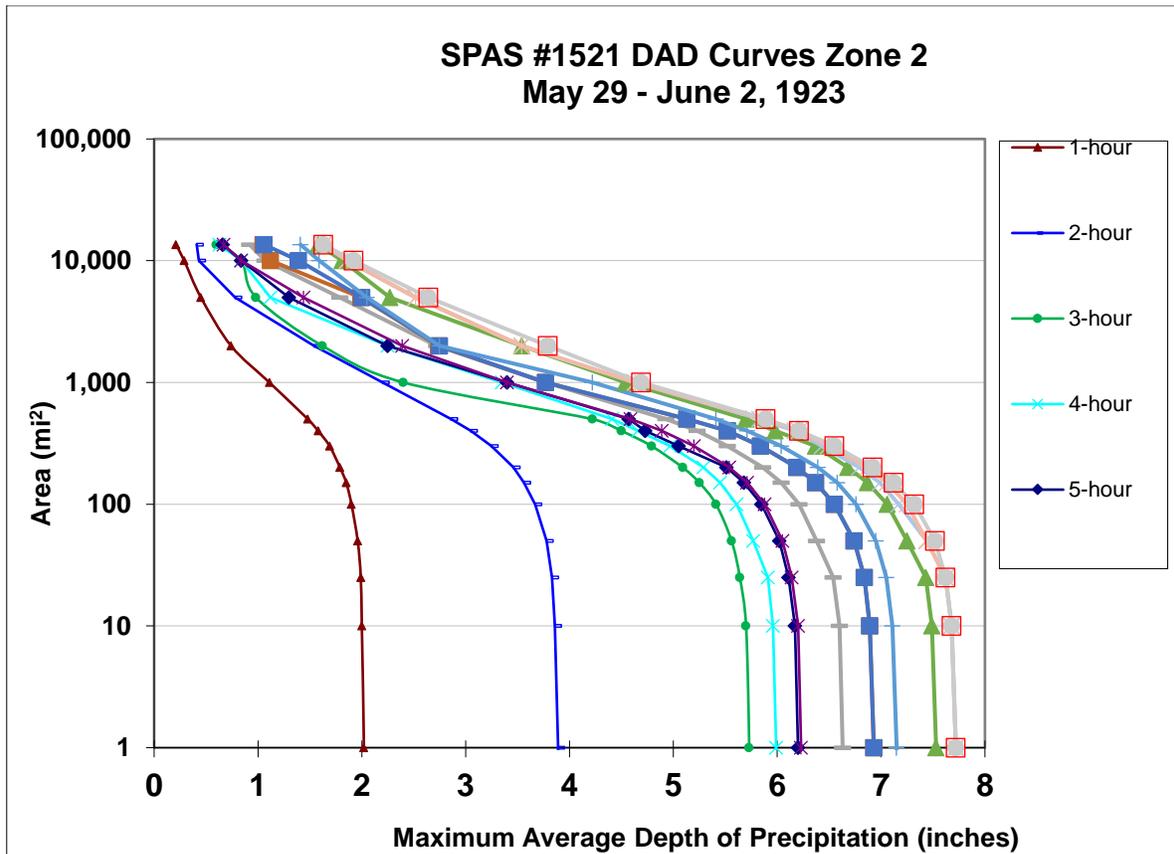
Spatial resolution: 30 second (degree: minute: second, WGS84, ~ 0.3 mi², 0.78 km²)

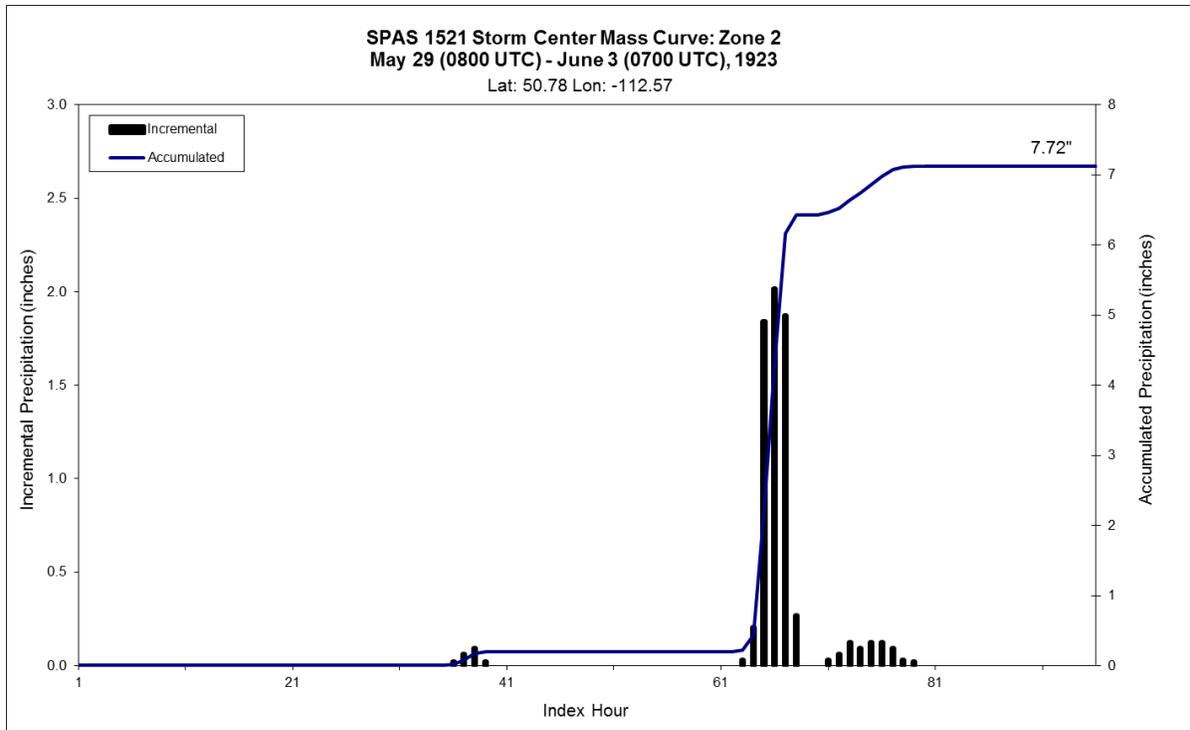
Radar Included: No

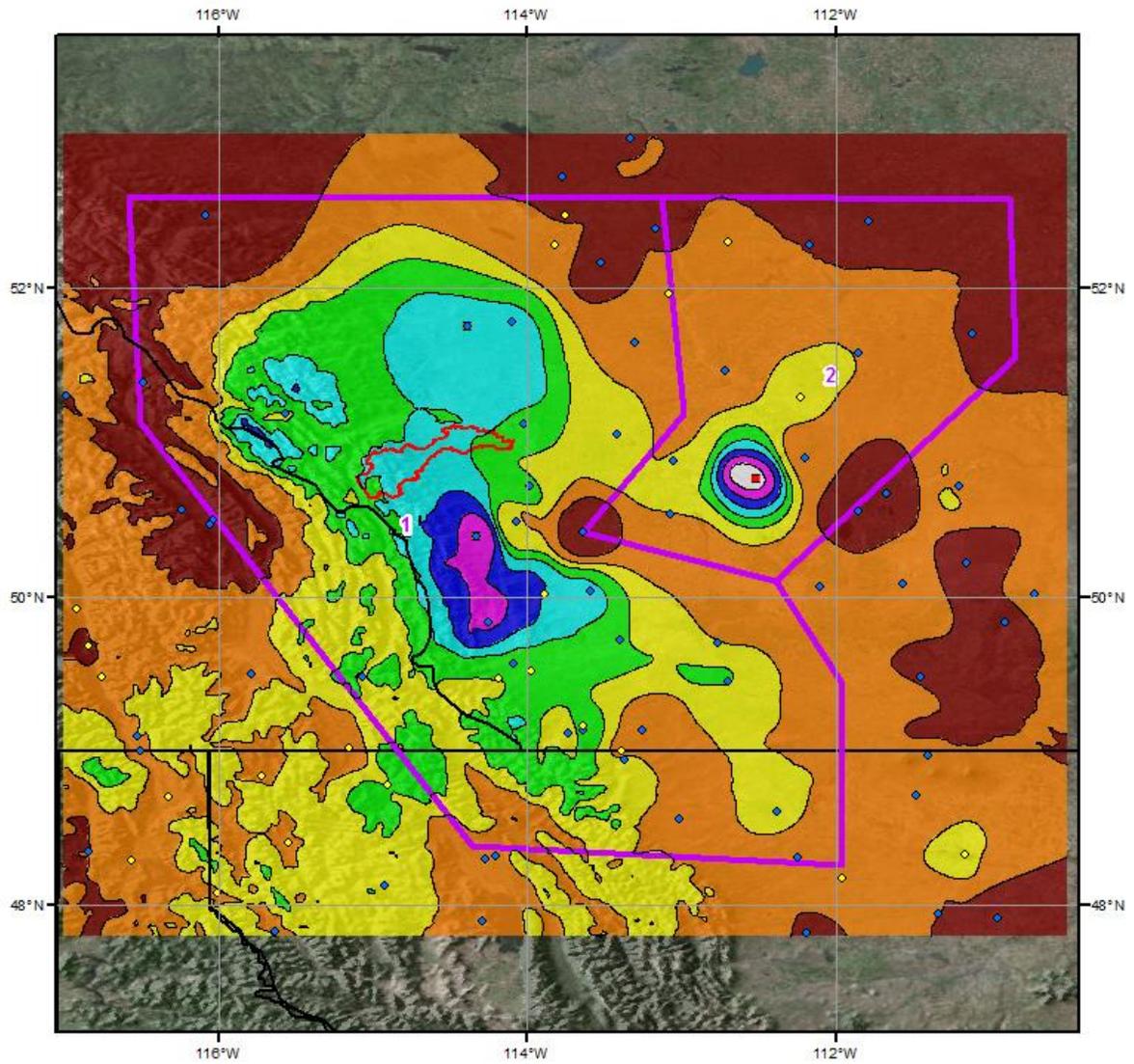
Depth-Area-Duration (DAD) analysis: Yes

Reliability of results: This analysis was based on hourly data, daily data, supplemental station data and AL 5-23 data. We have a good degree of confidence in the station based storm total results, the spatial pattern is dependent on the station data and a basemap. The timing is based on hourly and hourly pseudo stations.

Storm 1521 Zone 2 - May 29 (0800 UTC) - June 3 (0700 UTC), 1923															
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)															
areasqmi	Duration (hours)														
	1	2	3	4	5	6	12	18	24	36	48	72	96	120	Total
0.2	2.02	3.89	5.73	6.00	6.20	6.23	6.63	6.93	6.93	7.15	7.53	7.72	7.72	7.72	7.72
1	2.02	3.89	5.73	5.99	6.20	6.23	6.63	6.93	6.93	7.15	7.53	7.72	7.72	7.72	7.72
10	2.00	3.86	5.70	5.96	6.17	6.20	6.60	6.89	6.89	7.11	7.49	7.68	7.68	7.68	7.68
25	1.99	3.83	5.64	5.91	6.11	6.14	6.54	6.84	6.84	7.05	7.43	7.62	7.62	7.62	7.62
50	1.96	3.78	5.56	5.77	6.02	6.05	6.38	6.74	6.74	6.95	7.25	7.44	7.44	7.52	7.52
100	1.90	3.67	5.41	5.61	5.85	5.88	6.21	6.55	6.55	6.76	7.06	7.17	7.25	7.32	7.32
150	1.85	3.56	5.25	5.45	5.68	5.71	6.04	6.37	6.37	6.58	6.87	6.99	7.06	7.12	7.12
200	1.79	3.46	5.09	5.29	5.51	5.54	5.86	6.19	6.19	6.39	6.68	6.79	6.87	6.92	6.92
300	1.69	3.25	4.79	4.97	5.05	5.20	5.52	5.84	5.84	6.04	6.37	6.43	6.49	6.55	6.55
400	1.58	3.05	4.50	4.66	4.73	4.89	5.23	5.52	5.52	5.71	5.98	6.17	6.21	6.21	6.21
500	1.48	2.86	4.22	4.41	4.57	4.59	4.93	5.13	5.13	5.41	5.70	5.83	5.86	5.89	5.89
1,000	1.11	2.20	2.40	3.35	3.40	3.40	3.77	3.77	3.77	4.22	4.54	4.63	4.63	4.69	4.69
2,000	0.74	1.54	1.62	2.25	2.25	2.39	2.72	2.74	2.75	2.75	3.54	3.54	3.54	3.79	3.79
5,000	0.45	0.78	0.98	1.12	1.30	1.44	1.79	1.99	2.00	2.05	2.27	2.52	2.52	2.64	2.64
10,000	0.29	0.43	0.84	0.84	0.84	0.84	1.07	1.12	1.39	1.59	1.81	1.86	1.86	1.92	1.92
13,567	0.21	0.41	0.60	0.63	0.66	0.67	0.92	1.05	1.06	1.41	1.58	1.63	1.63	1.63	1.63







Total Storm (120-hr) Precipitation (inches)
5/29/1923 (0800 UTC) - 6/03/1923 (0700 UTC)
SPAS 1521

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental

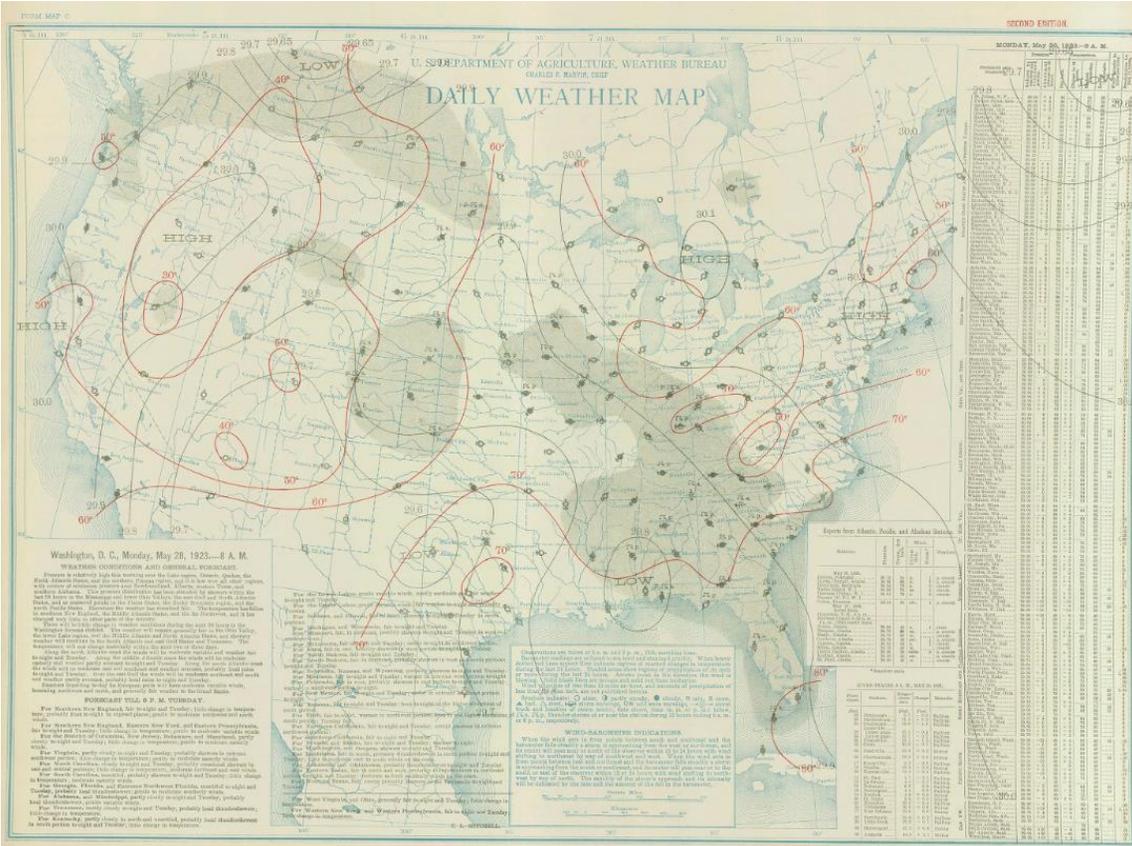
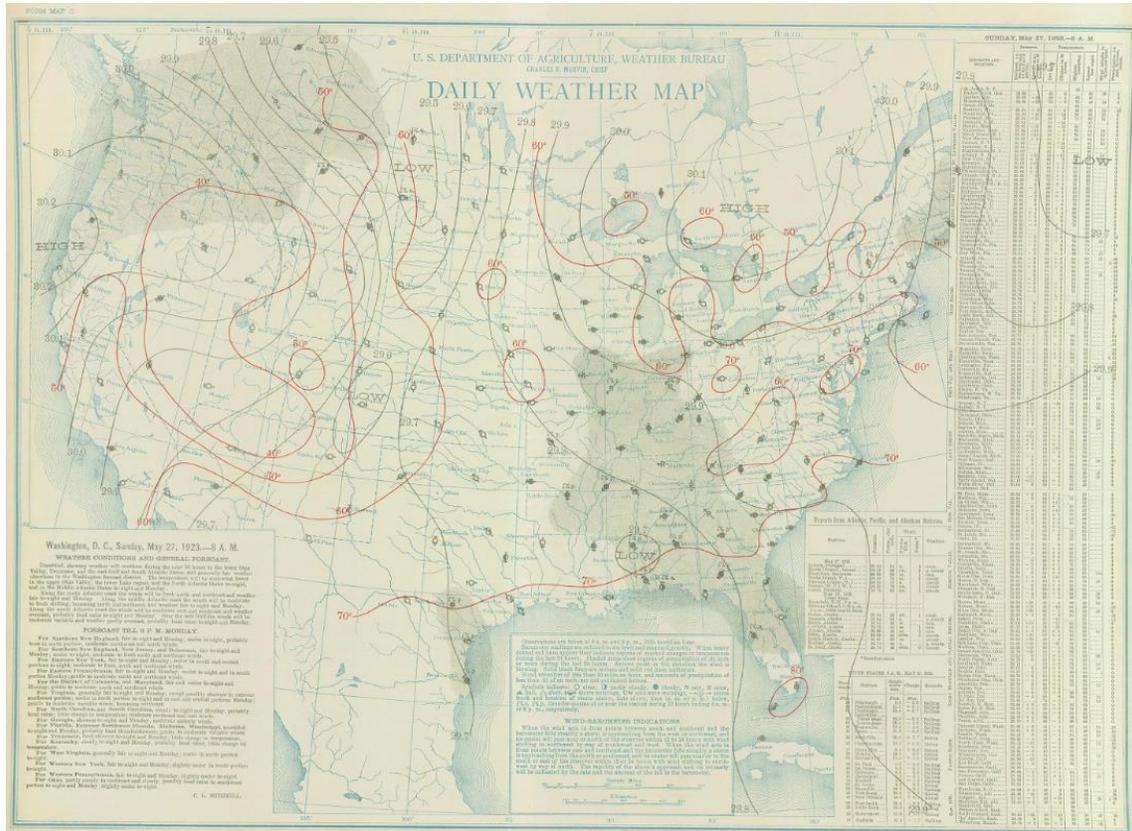


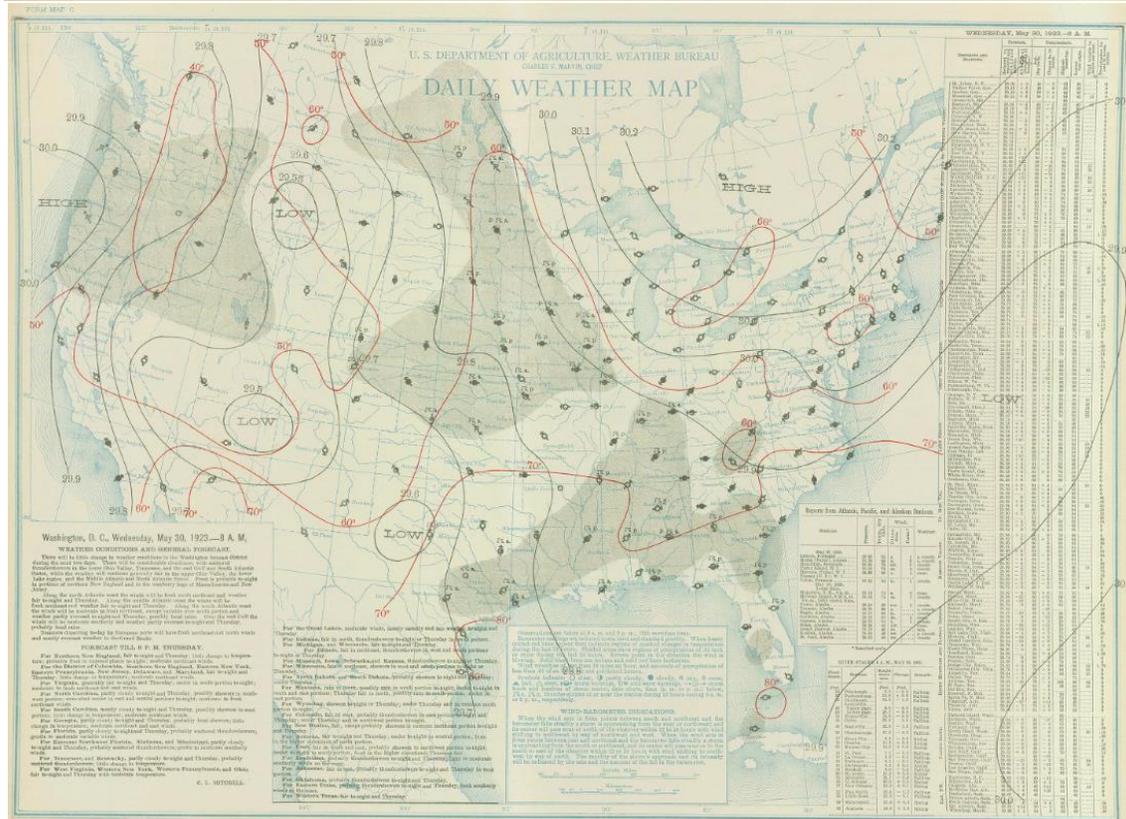
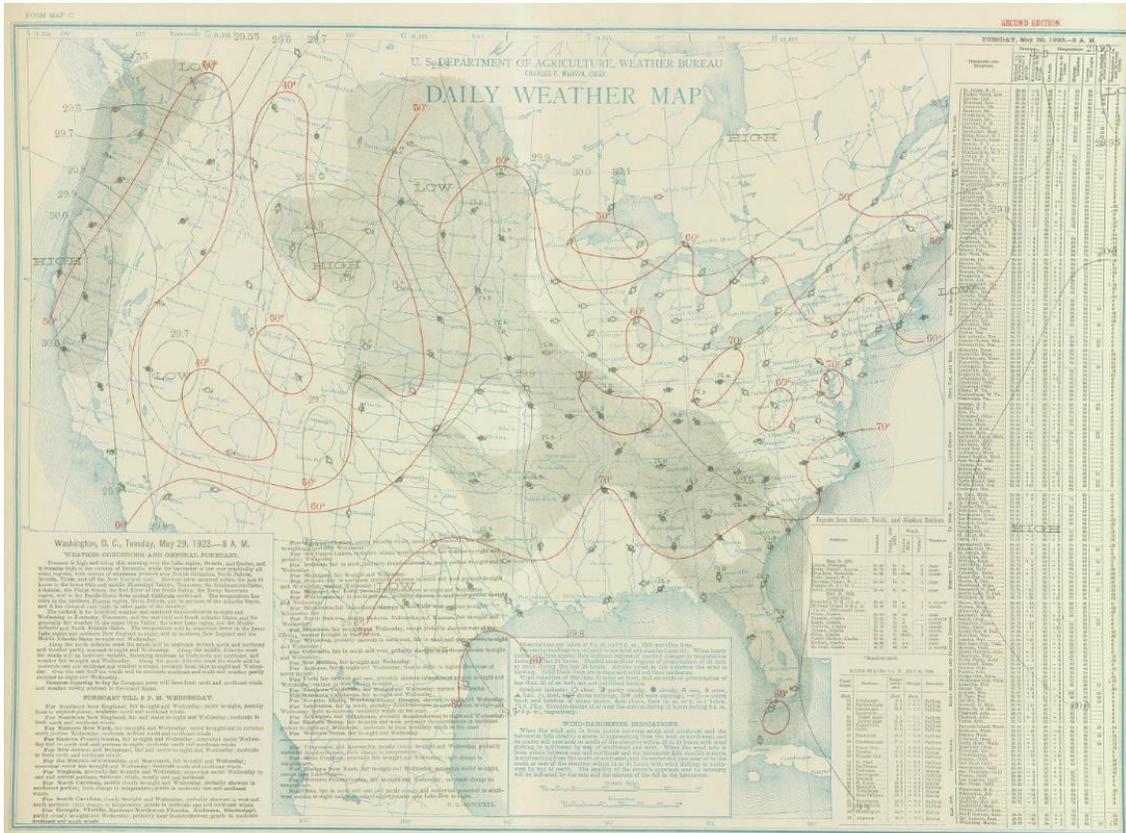
Precipitation (inches)

- | | | | |
|---------------|---------------|---------------|---------------|
| ■ 0.38 - 1.00 | ■ 2.01 - 3.00 | ■ 4.01 - 5.00 | ■ 6.01 - 7.00 |
| ■ 1.01 - 2.00 | ■ 3.01 - 4.00 | ■ 5.01 - 6.00 | ■ 7.01 - 8.00 |

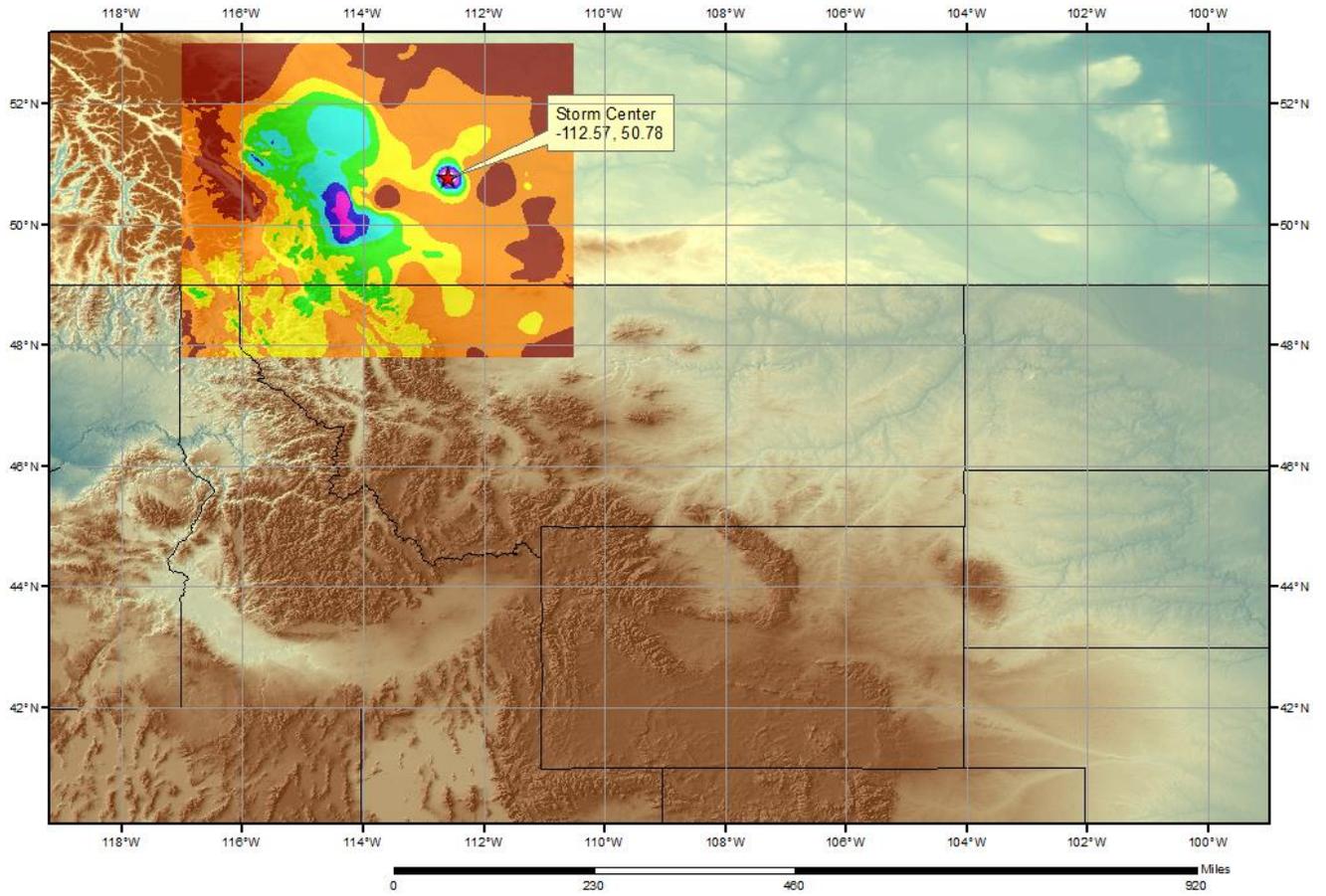


4/16/2015





SPAS 1521 Storm Analysis Zone 2 May 31- June 1, 1923



Storm Precipitation Analysis System (SPAS) For Storm #1427_1 SPAS Analysis

General Storm Location: Boyden, IA

Storm Dates: September 17 – September 18, 1926

Event: Extreme Precipitation Event

DAD Zone 1

Latitude: 43.1958

Longitude: -95.9958

Max. Grid Rainfall Amount: 24.22"

Max. Observed Rainfall Amount: 24.01"

Number of Stations: 159

SPAS Version: 10.0

Basemap: Manually digitized contours

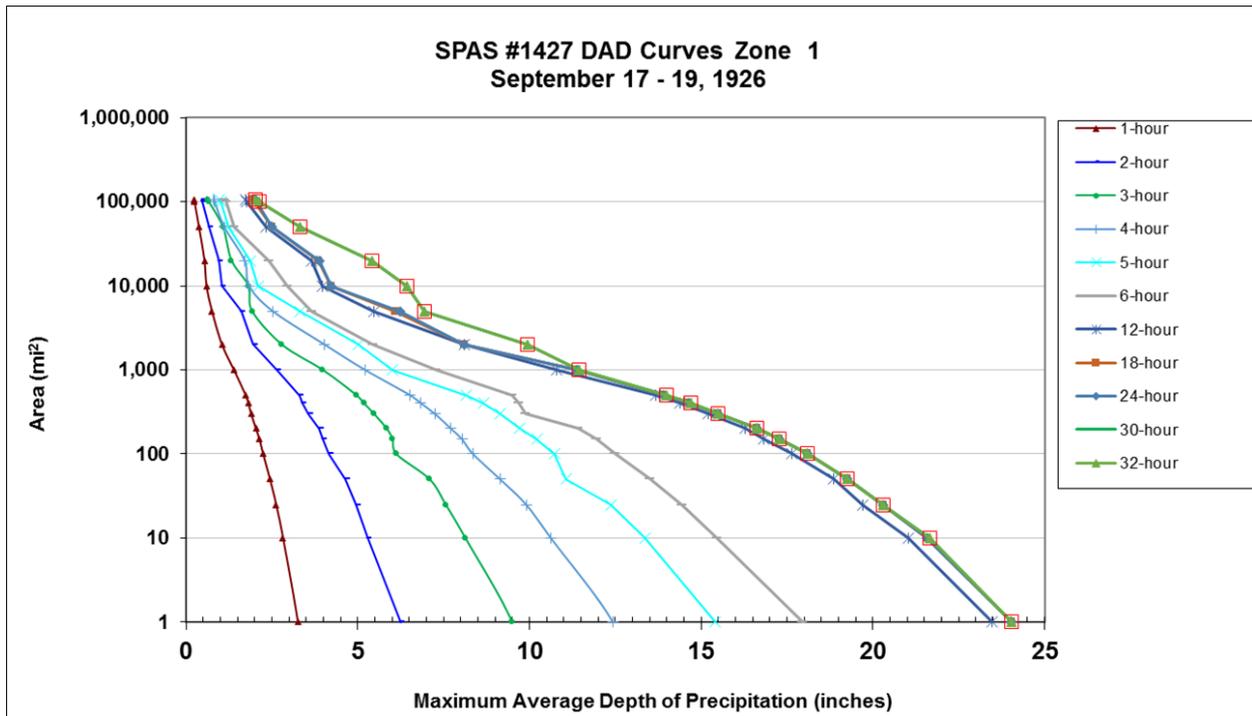
Spatial resolution: 0.242

Radar Included: No

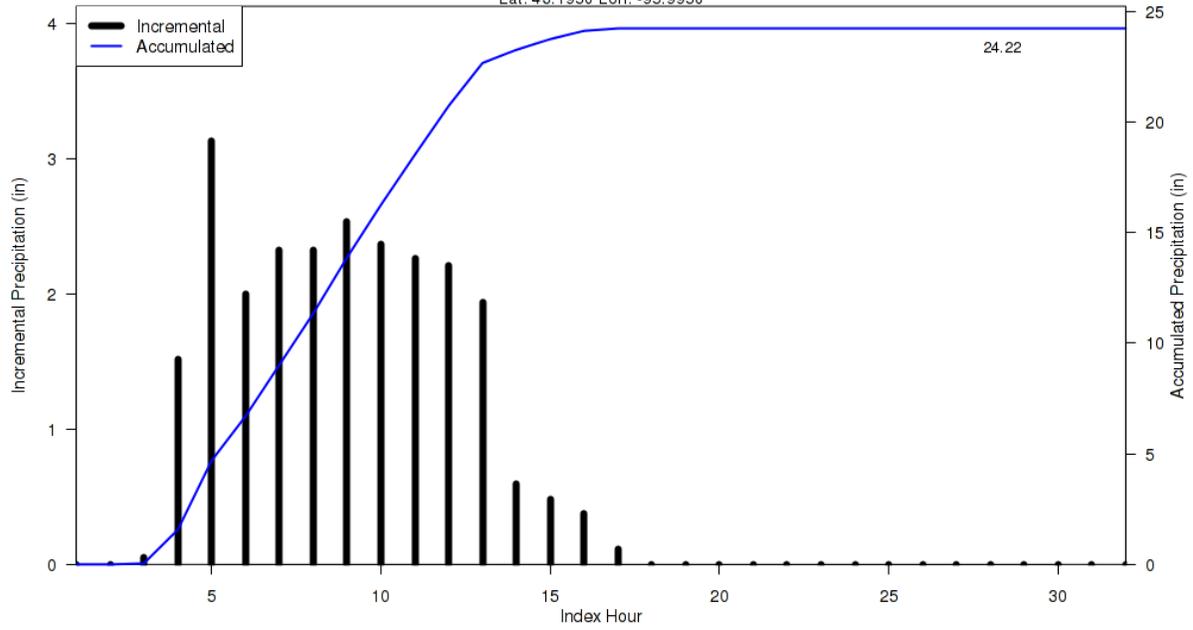
Depth-Area-Duration (DAD) analysis: Yes

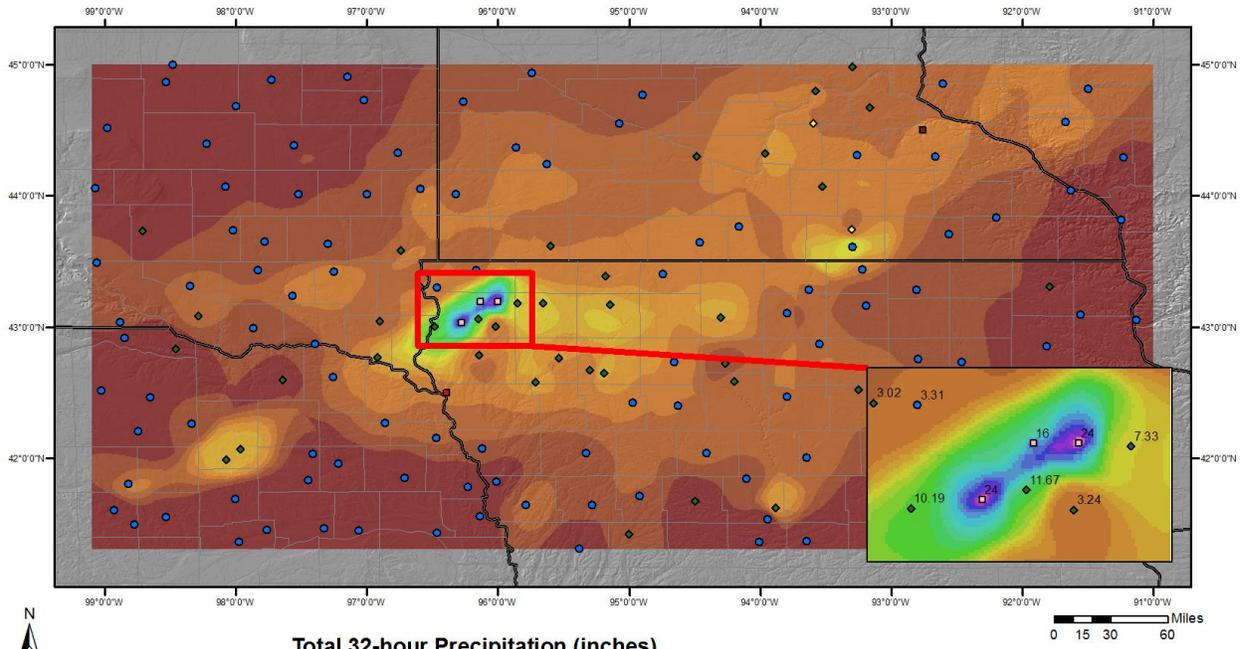
Reliability of results: In addition to the NCDC stations, four hourly stations were digitized from the U.S. Army Corp of Engineers (USACE) Storm Study Pertinent Data Sheet (included below). These stations only provided precipitation timing for the time period beginning on September 17 around 12:00 CST to 18:00 CST on September 18. Data mining also produced an additional supplemental station at Foss Field/Sioux Falls Regional Airport, SD. Due to the lack of hourly information, a 32-hour Core Precipitation Period (CPP) was established for this time period. While precipitation did fall outside of the CPP, results are unreliable due to the lack of data. In addition to the three digitized hourly stations, an additional estimated hourly station with 2.40 inches of accumulated precipitation over the CPP was created in order to represent later timing as the frontal passage moved eastward. The resulting DAD values are about equal to those of the previous analysis. There are slight deviations, both high and low, which are likely due to the original analysis over generalizing the storm area. For this reason, the current analysis is considered more reliable and represents a more accurate depiction of the event.

Storm 1427 - September 17 (1800 UTC) - September 19 (0100 UTC), 1926												
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)												
Area (mi ²)	Duration (hours)											
	1	2	3	4	5	6	12	18	24	30	32	Total
0.4	3.37	6.39	9.68	12.72	15.78	18.37	23.60	24.14	24.14	24.14	24.14	24.14
1	3.29	6.23	9.45	12.42	15.41	17.93	23.46	24.01	24.01	24.01	24.01	24.01
10	2.83	5.35	8.15	10.67	13.25	15.45	20.98	21.48	21.48	21.48	21.48	21.48
25	2.62	4.97	7.57	9.91	12.33	14.38	19.73	20.17	20.17	20.17	20.17	20.17
50	2.44	4.62	7.06	9.20	11.48	13.41	18.79	19.18	19.19	19.19	19.19	19.19
100	2.24	4.25	6.47	8.46	10.60	12.43	17.62	18.04	18.04	18.04	18.04	18.04
200	2.03	3.88	5.89	7.71	9.66	11.32	16.17	16.51	16.51	16.51	16.51	16.51
300	1.90	3.63	5.45	7.17	8.98	10.52	15.10	15.41	15.42	15.42	15.42	15.42
400	1.81	3.45	5.16	6.82	8.51	9.94	14.21	14.50	14.51	14.51	14.51	14.51
500	1.73	3.32	4.96	6.55	8.16	9.50	13.49	13.77	13.78	13.78	13.78	13.78
1,000	1.40	2.67	4.00	5.28	6.57	7.68	11.07	11.33	11.35	11.35	11.35	11.35
2,000	1.03	1.98	2.93	3.86	4.83	5.73	8.55	8.94	9.03	9.03	9.03	9.03
5,000	0.79	1.50	2.18	2.73	3.32	3.89	6.20	6.60	6.69	6.69	6.69	6.69
10,000	0.65	1.26	1.80	2.24	2.66	3.09	4.90	5.34	5.43	5.43	5.43	5.43
20,000	0.53	1.02	1.44	1.82	2.15	2.49	3.87	4.33	4.40	4.40	4.40	4.40
50,000	0.38	0.72	1.05	1.31	1.53	1.73	2.66	2.99	3.08	3.08	3.08	3.08
100,000	0.24	0.47	0.66	0.83	1.01	1.16	1.79	2.02	2.06	2.06	2.06	2.06
104,550	0.23	0.45	0.64	0.81	0.96	1.12	1.74	1.97	2.01	2.01	2.01	2.01



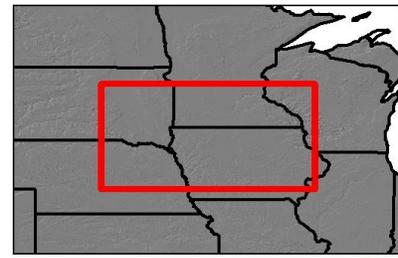
SPAS 1427 Storm Center Mass Curve Zone 1
September 17 (1800UTC) to September 19 (0100UTC), 1926
Lat: 43.1958 Lon: -95.9958





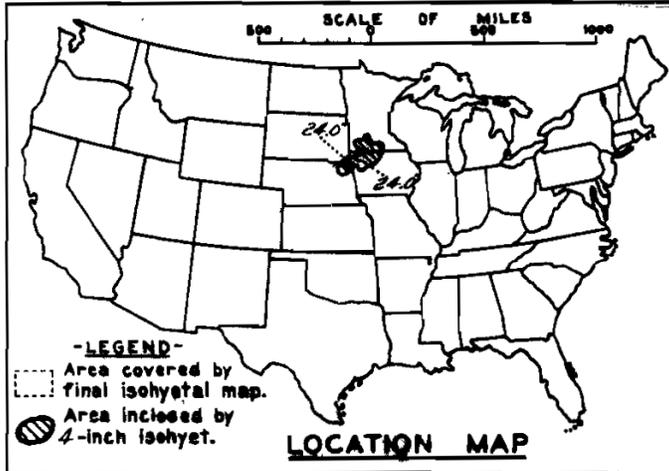
Total 32-hour Precipitation (inches)
September 17, 1926 1800 UTC - September 19, 1926 0100 UTC
SPAS #1427

Stations	Precipitation (inches)											
● Daily	0.12 - 1.00	6.01 - 7.00	12.01 - 13.00	18.01 - 19.00								
■ Hourly	1.01 - 2.00	7.01 - 8.00	13.01 - 14.00	19.01 - 20.00								
□ Hourly Estimated	2.01 - 3.00	8.01 - 9.00	14.01 - 15.00	20.01 - 21.00								
■ Hourly Estimated Pseudo	3.01 - 4.00	9.01 - 10.00	15.01 - 16.00	21.01 - 22.00								
◆ Supplemental	4.01 - 5.00	10.01 - 11.00	16.01 - 17.00	22.01 - 23.00								
◆ Supplemental Estimated	5.01 - 6.00	11.01 - 12.00	17.01 - 18.00	23.01 - 24.00								
					24.00 +							



ADH 10/24/2014

STORM STUDIES - PERTINENT DATA SHEET



Storm of 17-19 September 1926
 Assignment MR 4-24
 Location Ia, Minn, Nebr. S.D. & Wis
 Study Prepared by:
 Missouri River Division
 Omaha District Office

Part I Reviewed by H. M. Sec. of
 Weather Bureau, 8/5/47
 Part II Approved by Office, Chief
 of Engineers for Distribution
 of Factual Data, 12/25/47
 Remarks: Centers near
 Boyden & Maurice, Ia.
 Dewpt. 70° - Ref. Pt. 175 SSE
 Grid C-15

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheets, scale 1:500,000
 Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data)-----	8
Form 5001-B (24-hour " ")-----	-
Form 5001-D (" " " ")-----	11
Misc. precip. records, meteorological data, etc.-----	29
Form 5002 (Mass rainfall curves)-----	27

PART II

Final isohyetal maps, in 1 sheet, scale 1:1,000,000
 Data and computation sheets:

Form S-10 (Data from mass rainfall curves)-----	3
Form S-11 (Depth-area data from isohyetal map)-----	2
Form S-12 (Maximum depth-duration data)-----	17
Maximum duration-depth-area curves-----	1
Data relating to periods of maximum rainfall-----	7

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

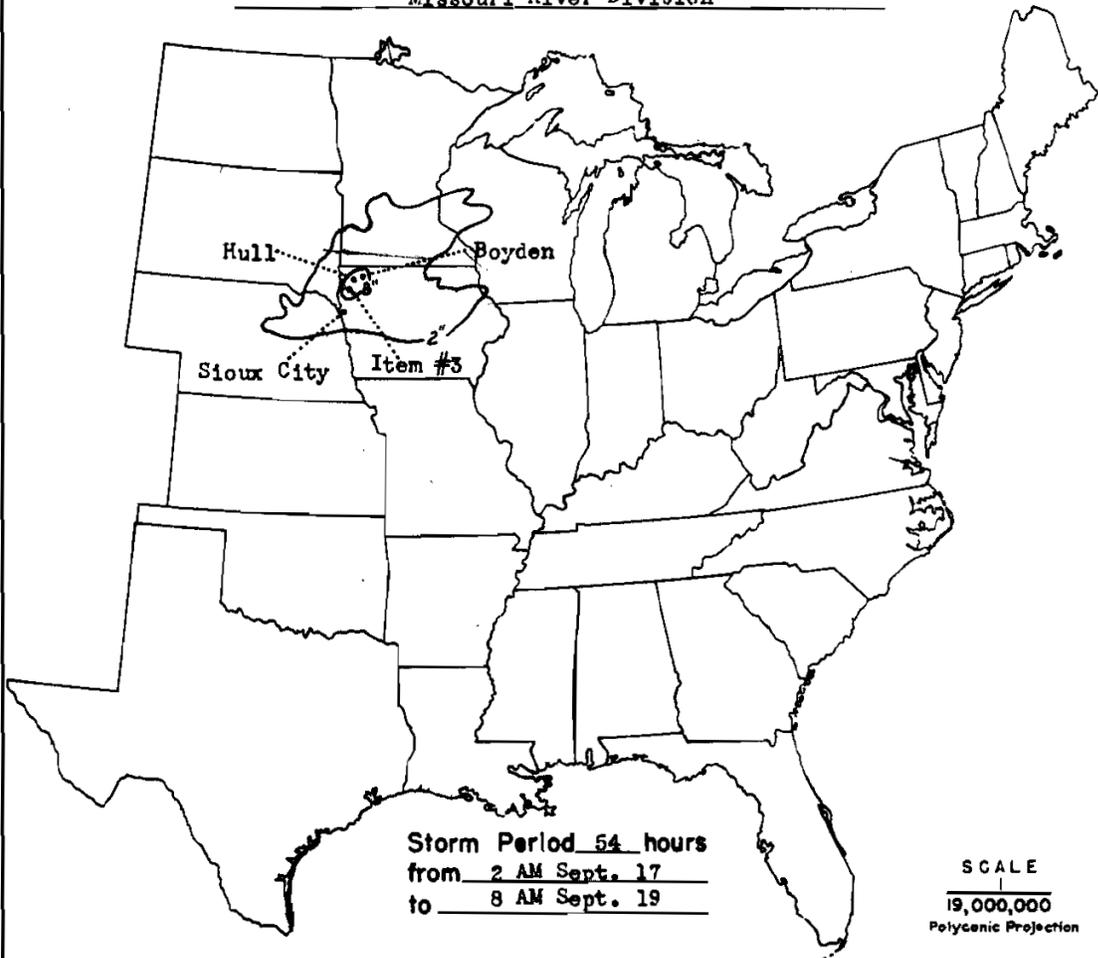
Area in Sq. Mi.	Duration of Rainfall in Hours								
	6	12	18	24	30	36	48	54	
Max. Station	18.4	23.8	24.0	24.0	24.0	24.0	24.0	24.0	
10	15.1	20.7	21.7	21.7	21.7	21.7	21.7	21.7	
100	12.8	17.1	17.8	17.8	17.8	17.8	17.8	17.8	
200	11.7	15.8	16.6	16.6	16.6	16.6	16.6	16.6	
500	9.4	12.6	13.3	13.3	13.3	13.3	13.3	13.3	
1,000	7.5	10.1	10.4	10.6	10.6	10.6	10.6	10.6	
2,000	5.9	8.0	8.2	8.6	8.6	8.6	8.6	8.6	
5,000	4.1	6.3	6.4	6.6	6.6	6.6	6.6	6.6	
10,000	3.0	5.2	5.4	5.5	5.6	5.6	5.6	5.6	
20,000	2.1	4.1	4.3	4.4	4.6	4.8	4.9	4.9	
50,000	1.4	2.7	2.9	3.0	3.2	3.6	3.8	3.8	
63,000	1.2	2.4	2.6	2.7	2.9	3.3	3.5	3.5	

DEPARTMENT OF THE ARMY

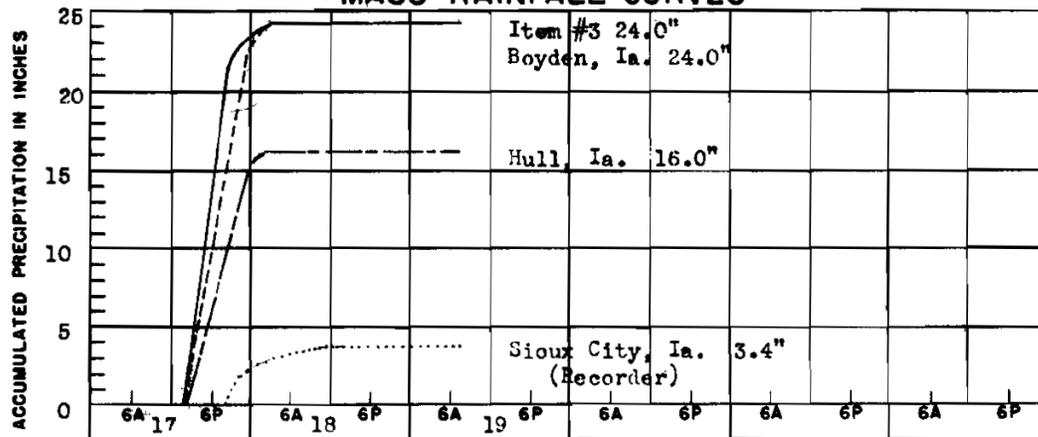
CORPS OF ENGINEERS

STORM STUDIES - ISOHYETAL MAP

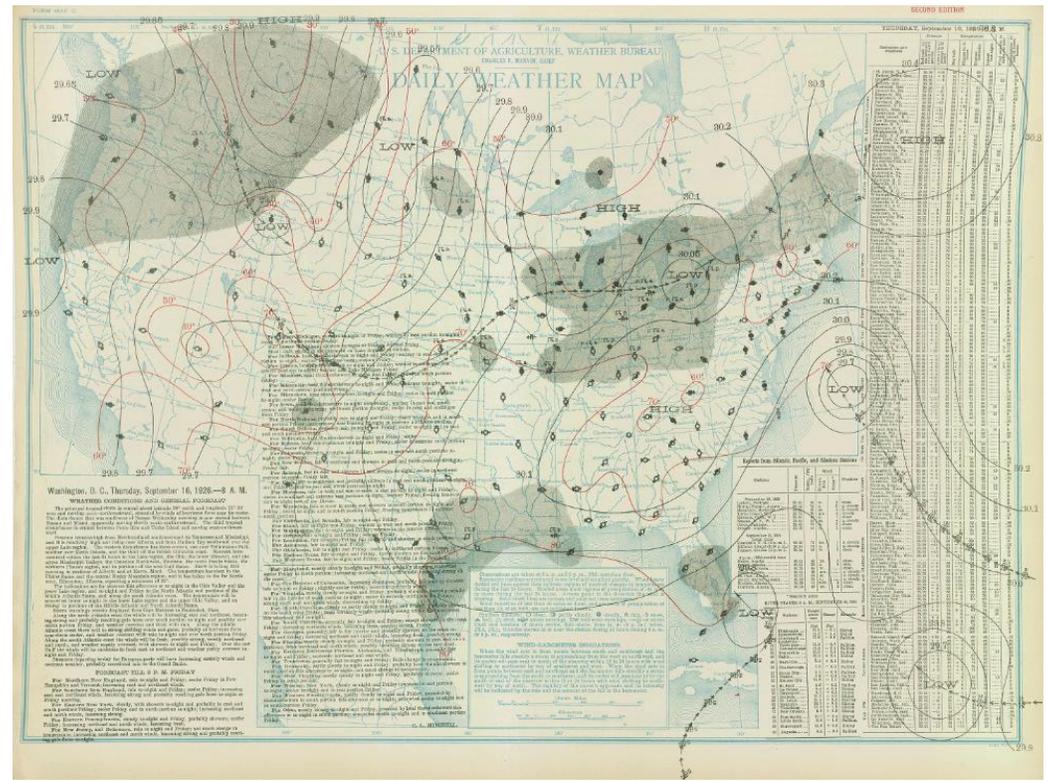
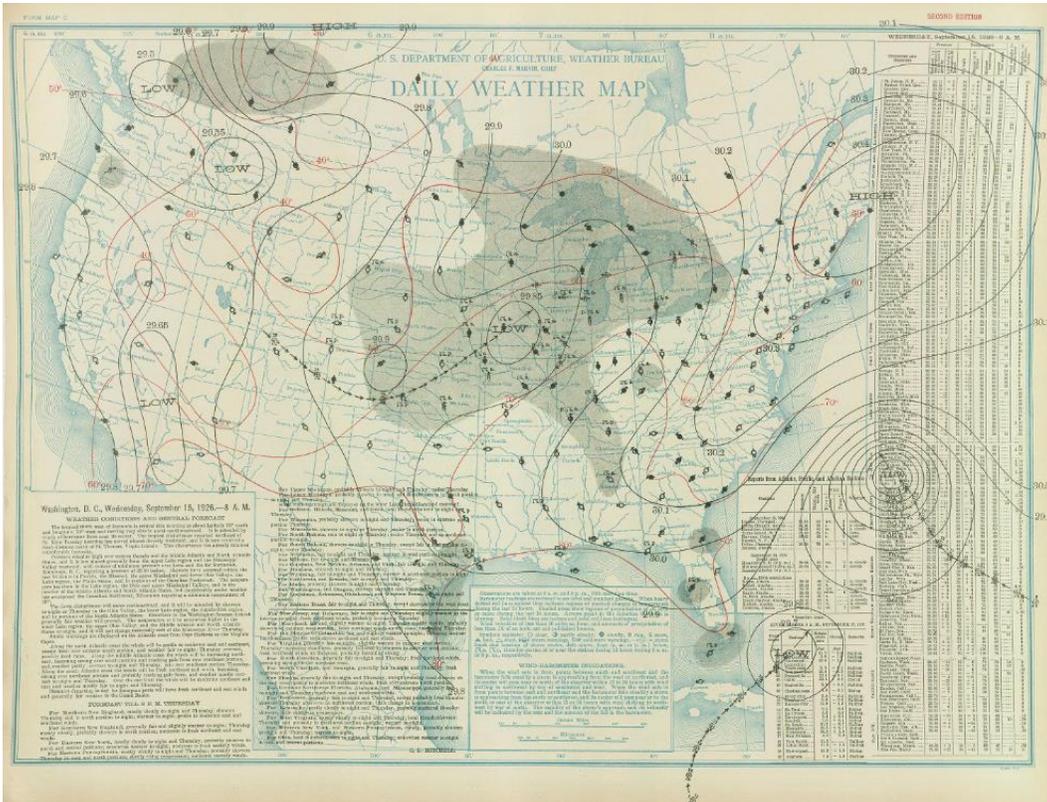
Storm of 17-19 September 1926 Assignment MR 4-24
 Study Prepared by: Omaha, Nebr. District
Missouri River Division



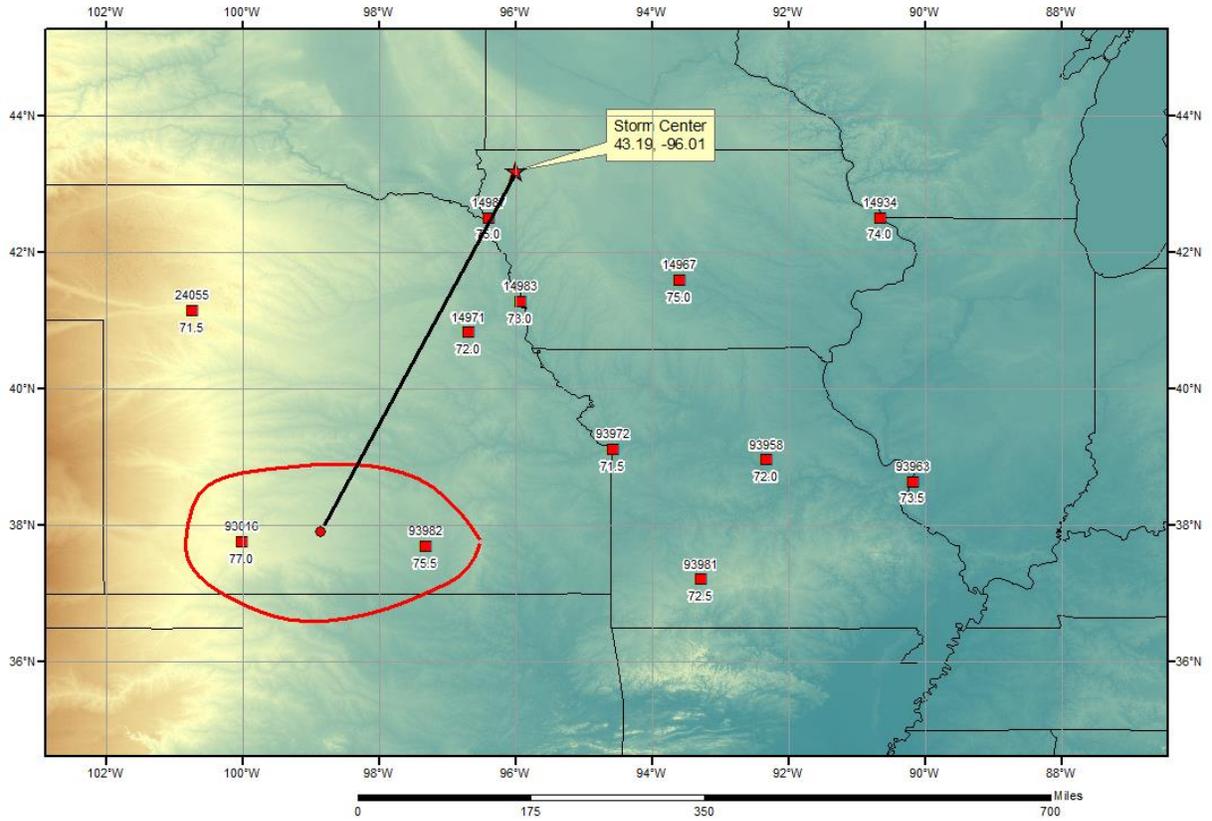
MASS RAINFALL CURVES



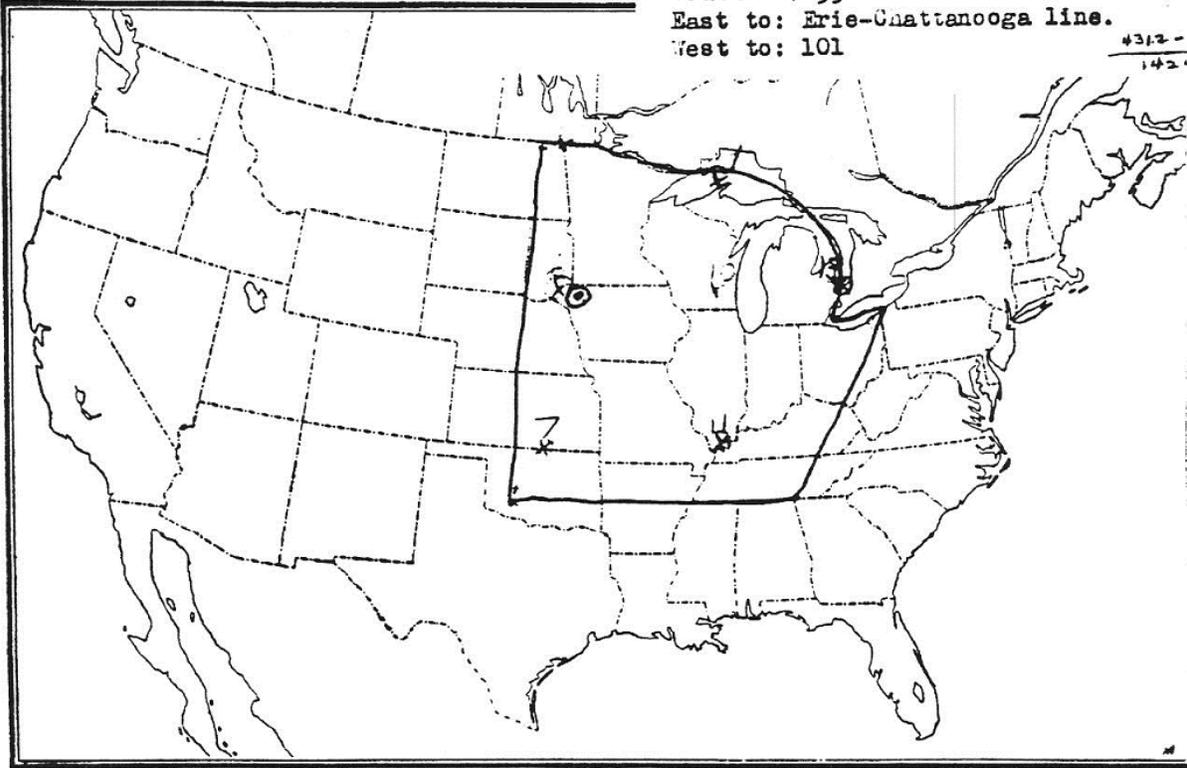
FORM 8-3E



Boyden, IA Storm Analysis September 15-18, 1926



MR 4-24..Sept. 17-19, 1926..Boyd, I
12-hr. rfd 70(18tn)..175 SSE.. to 7b,
North to: Border
South to: 35
East to: Erie-Chattanooga line.
West to: 101



Storm Precipitation Analysis System (SPAS) For Storm #1736_1 SPAS Analysis

General Storm Location: Stanton, NE

Storm Dates: June 9-13, 1944

Event: General

DAD Zone 1

Latitude: 41.8208

Longitude: -97.0292

Max. Grid/Radar Rainfall Amount: 17.49"

Max. Observed Rainfall Amount: 17.40"

Number of Stations: 905

Base Map Used: Blend of Isohyetal Map and Conus PRISM Climatology

Spatial resolution: 0.2427

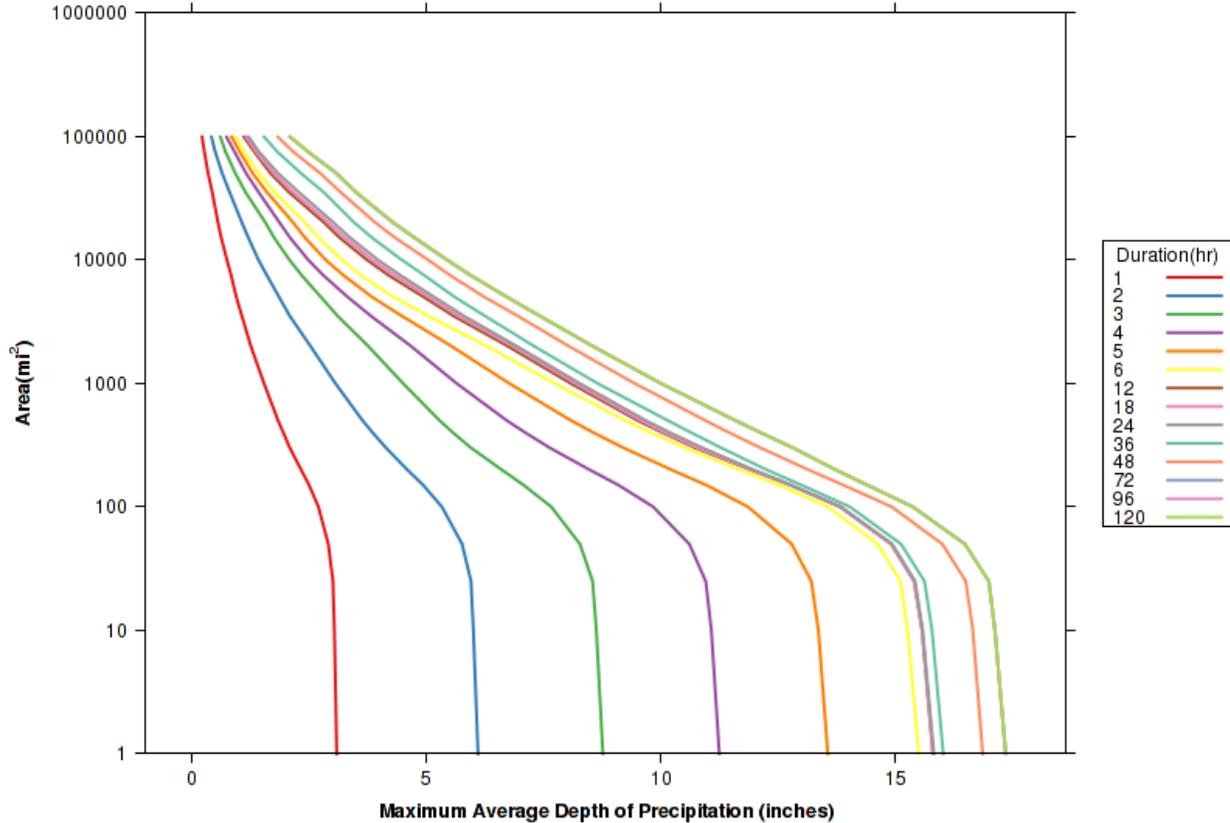
Radar Included: No

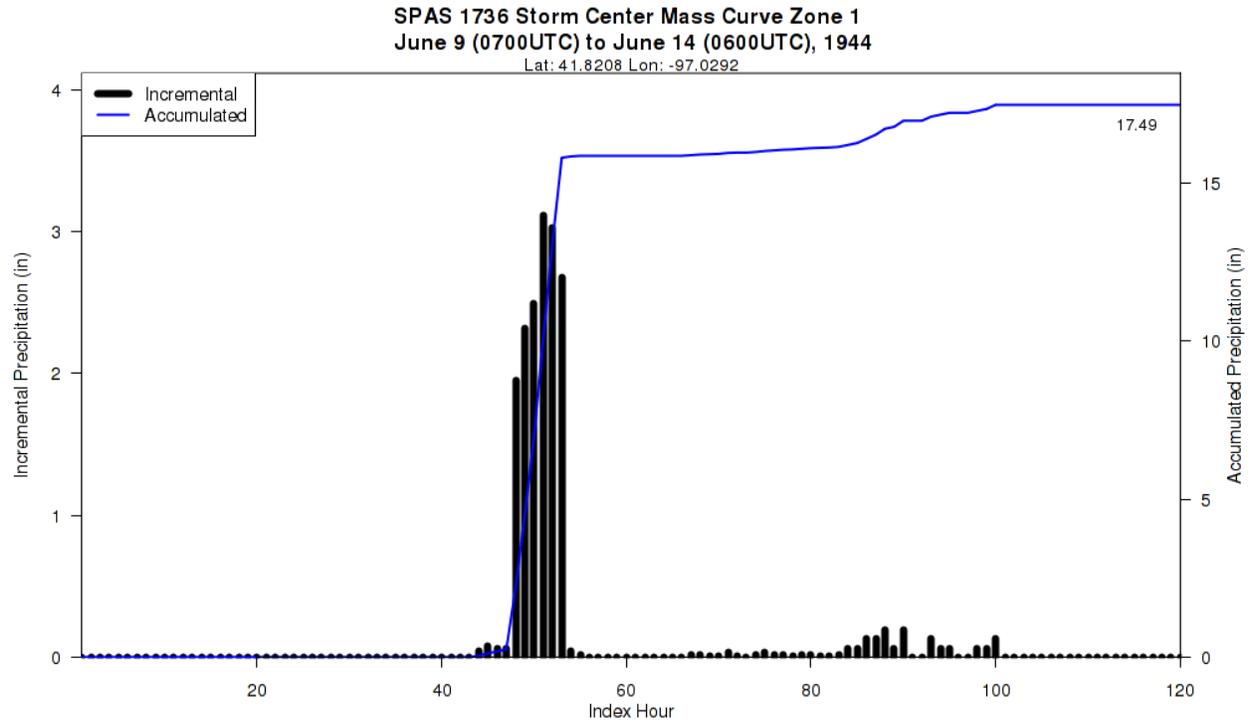
Depth-Area-Duration (DAD) analysis: Yes

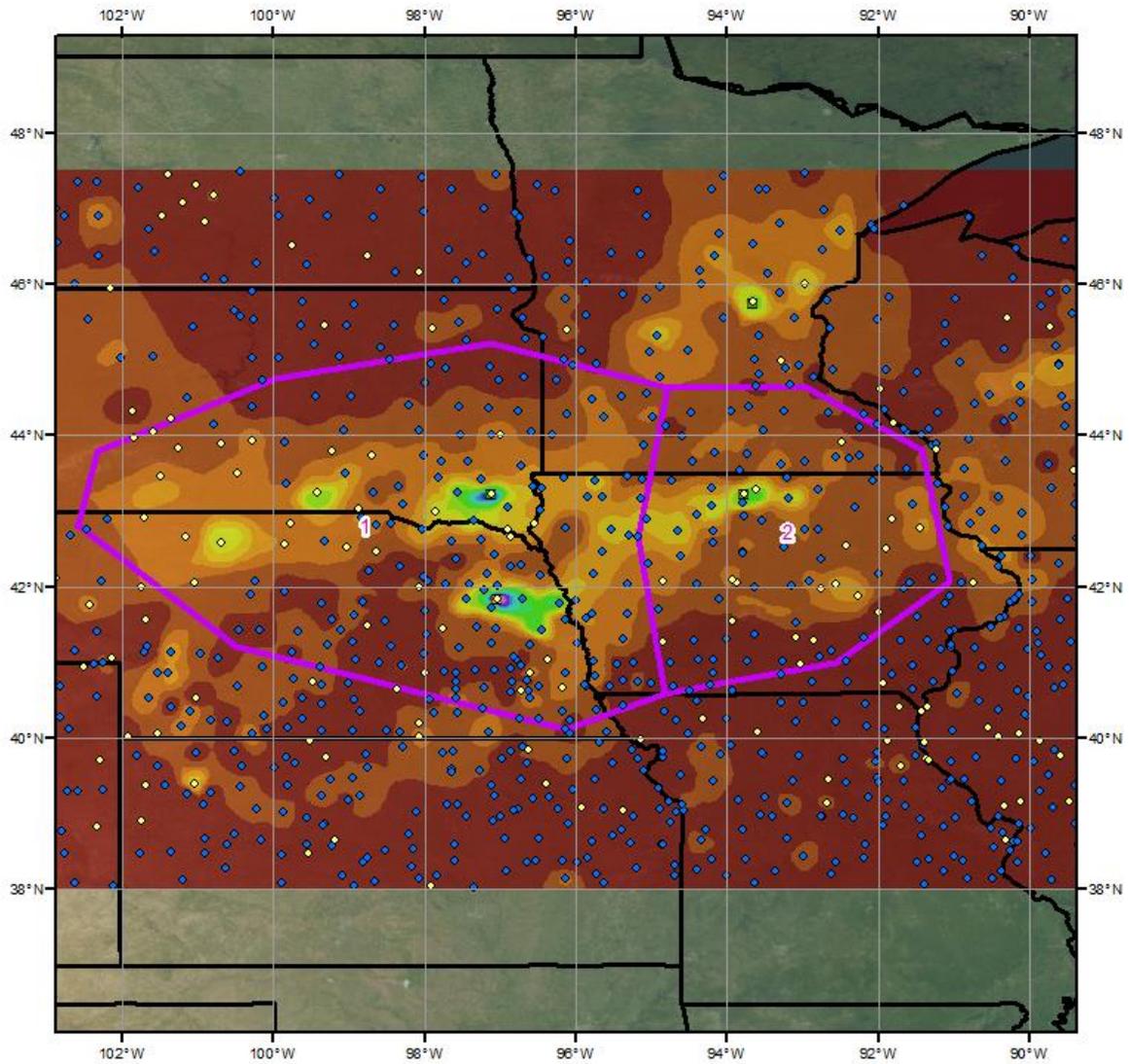
Reliability of Results: This analysis was based on 905 hourly pseudo stations, daily data, and supplemental station data. We have a good degree of confidence for the station based storm total results. The spatial pattern is fully dependent on the blended basemap. Timing is based on the hourly pseudo stations created from the mass curves in USACE storm study MR 6-15. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

SPAS 1736 - June 9 (0700 UTC) - June 14 (0600 UTC), 1944											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
Area (mi ²)	Duration (hours)										
	1	6	12	18	24	36	48	72	96	120	Total
0.4	3.11	15.57	15.87	15.87	15.89	16.10	16.95	17.44	17.44	17.44	17.44
1	3.10	15.50	15.80	15.80	15.82	16.02	16.86	17.35	17.35	17.35	17.35
10	3.05	15.26	15.57	15.57	15.58	15.78	16.65	17.12	17.12	17.12	17.12
25	3.02	15.11	15.40	15.40	15.42	15.62	16.50	16.99	16.99	16.99	16.99
50	2.92	14.62	14.91	14.91	14.93	15.12	16.00	16.48	16.48	16.48	16.48
100	2.71	13.56	13.82	13.82	13.84	14.03	14.92	15.37	15.37	15.37	15.37
200	2.34	11.68	11.91	11.93	11.97	12.25	13.14	13.72	13.72	13.72	13.72
300	2.10	10.52	10.74	10.79	10.89	11.29	12.13	12.82	12.82	12.82	12.82
400	1.96	9.78	10.03	10.08	10.19	10.64	11.45	12.12	12.12	12.12	12.12
500	1.85	9.24	9.51	9.58	9.68	10.15	10.95	11.59	11.59	11.59	11.59
1,000	1.55	7.74	8.08	8.18	8.27	8.65	9.44	10.00	10.00	10.00	10.00
2,000	1.27	6.29	6.74	6.85	6.93	7.30	8.04	8.55	8.55	8.55	8.55
5,000	0.96	4.31	4.95	5.06	5.17	5.61	6.24	6.72	6.72	6.72	6.72
10,000	0.76	3.21	3.74	3.85	3.97	4.48	5.04	5.44	5.45	5.45	5.45
20,000	0.57	2.42	2.83	2.92	3.03	3.47	3.92	4.29	4.31	4.31	4.31
50,000	0.36	1.44	1.69	1.76	1.85	2.34	2.75	3.09	3.10	3.10	3.10
99,026	0.23	0.95	1.12	1.17	1.22	1.55	1.84	2.10	2.10	2.10	2.10

**SPAS 1736 DAD Curves Zone 1
June 9 (0700UTC) to June 14 (0600UTC), 1944**





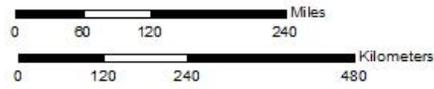


Total Storm (120-hours) Precipitation (inches)
June 9-13, 1944
SPAS 1736 - Stanton, NE

Gauges

Type

- ◆ Daily
- Hourly
- HEP
- Hourly Pseudo
- ◇ Supplemental



STORM STUDIES - PERTINENT DATA SHEET



Storm of 10-13 June 1944
 Assignment MR 6-15
 Location Ia., Nebr., S. Dak.
 Study Prepared by:
 Missouri River Division
 Omaha District Office

Part I Reviewed by H. M. Sec. of
 Weather Bureau, 8/7/46
 Part II Approved by Office, Chief
 of Engineers for Distribution
 of Factual Data, 2/10/48
 Remarks: Center near
 Stanton, Nebr.
 Dewpt. 70°- Ref. Pt. 125 SSE
 Grid D-16

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheets, scale 1:500,000
 Precipitation data and mass curves: (Number of Sheets)

Form 5001-C (Hourly precip. data).....	56
Form 5001-B (24-hour " " " ").....	-
Form 5001-D (" " " " " ").....	19
Misc. precip. records, meteorological data, etc.....	11
Form 5002 (Mass rainfall curves).....	34

PART II

Final isohyetal maps, in 1 sheet, scale 500,000
 Data and computation sheets:

Form S-10 (Data from mass rainfall curves).....	3
Form S-11 (Depth-area data from isohyetal map).....	2
Form S-12 (Maximum depth-duration data).....	13
Maximum duration-depth-area curves.....	1
Data relating to periods of maximum rainfall.....	5

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	30	36	48	60	72	78
Max. Sta.	15.5	15.8	15.8	15.8	15.8	15.8	16.8	17.3	17.3	17.3
10	13.4	15.3	15.3	15.3	15.3	15.3	16.2	16.4	16.7	16.7
100	11.7	13.6	13.6	13.6	13.6	13.7	14.8	14.9	15.1	15.1
200	11.1	12.9	12.9	12.9	12.9	13.1	14.1	14.3	14.4	14.4
500	9.8	11.3	11.5	11.5	11.5	11.6	12.5	12.7	12.8	12.8
1,000	7.8	9.0	9.3	9.3	9.3	9.4	10.1	10.4	10.4	10.4
2,000	5.9	6.9	7.1	7.1	7.2	7.3	7.8	8.1	8.1	8.1
5,000	3.4	4.0	4.2	4.6	4.7	4.9	5.3	5.5	5.7	5.8
10,000	2.2	2.5	2.7	3.5	3.9	4.1	4.5	4.7	4.9	5.0
16,000	1.8	2.0	2.2	2.9	3.5	3.7	4.1	4.3	4.5	4.6

DEPARTMENT OF THE ARMY

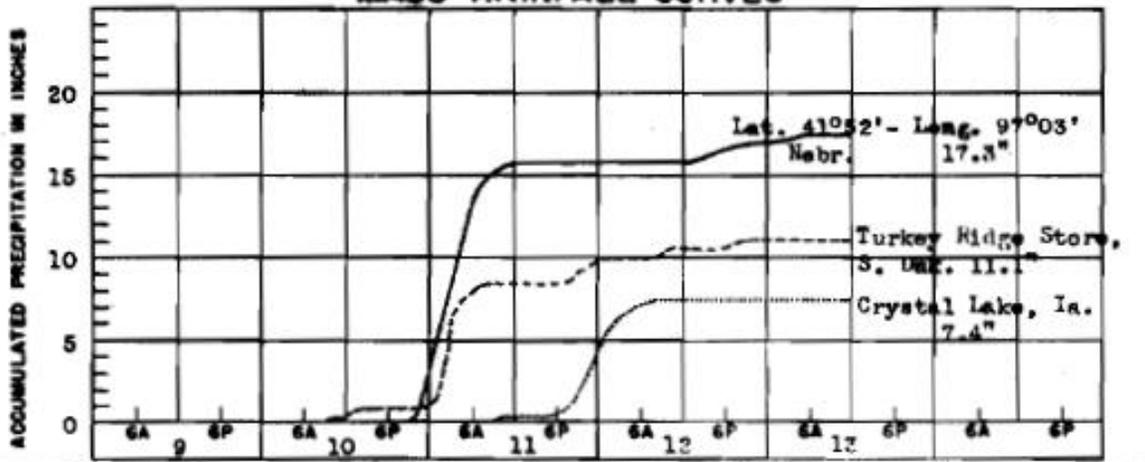
CORPS OF ENGINEERS

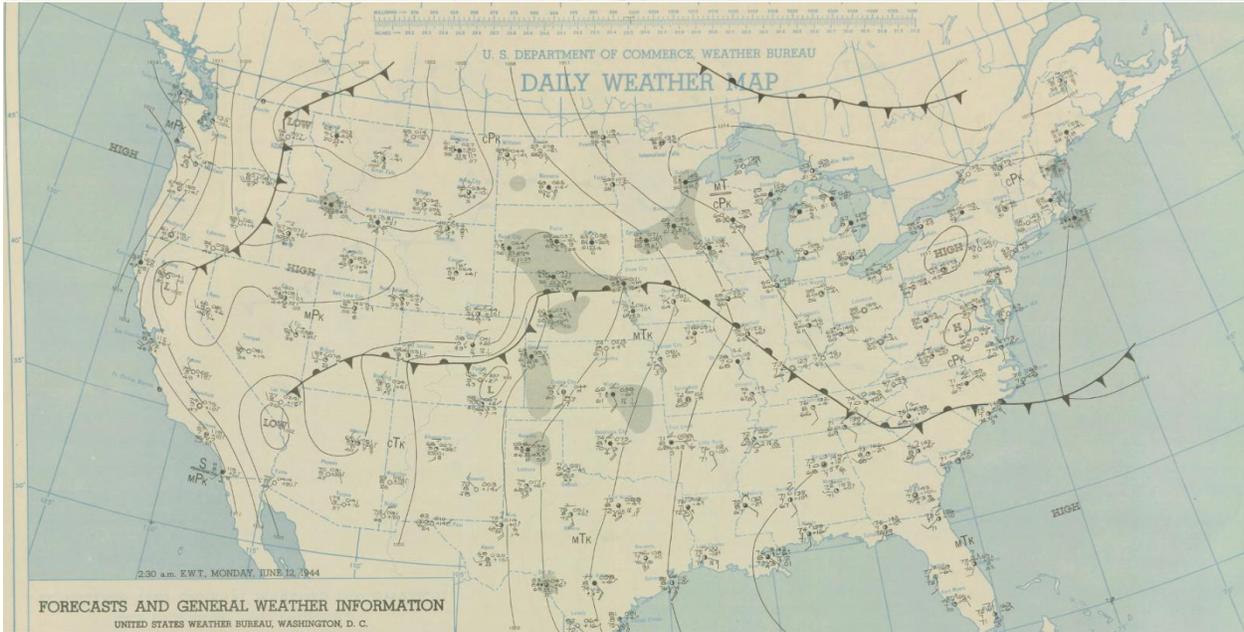
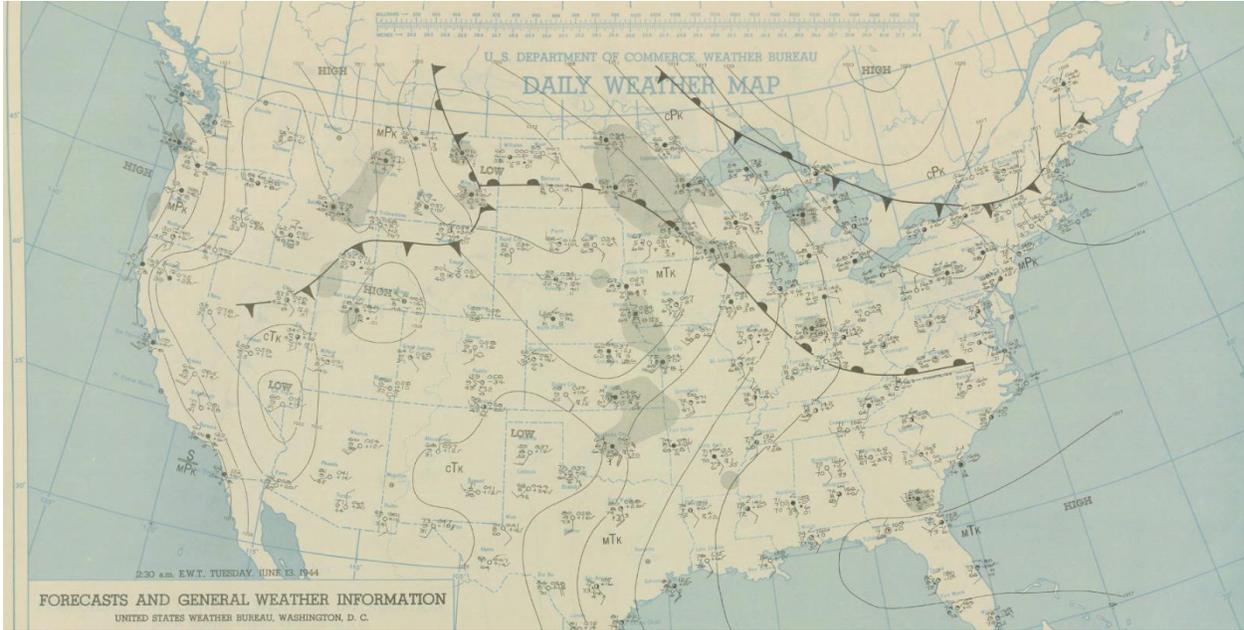
STORM STUDIES - ISOHYETAL MAP

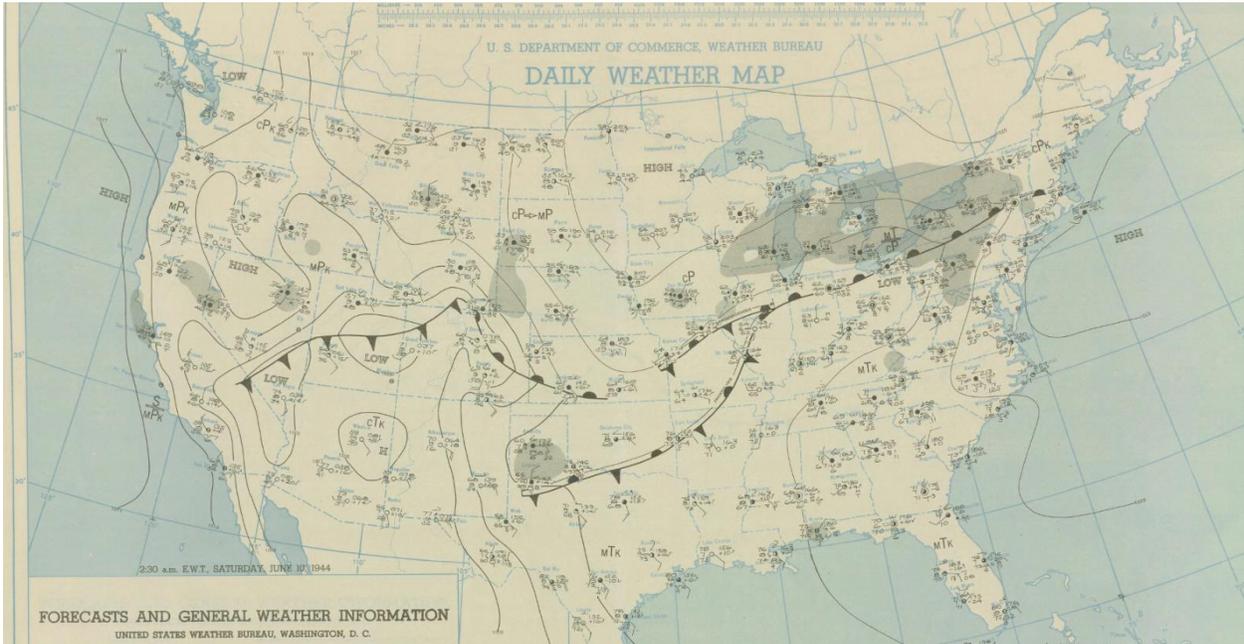
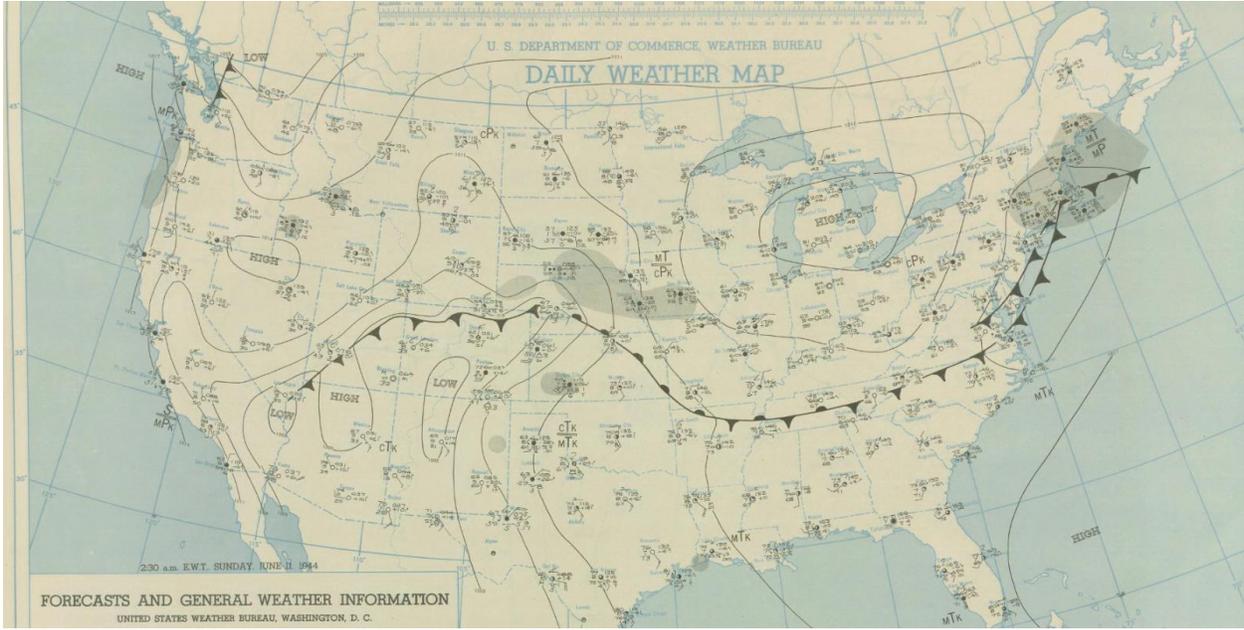
Storm of 10-13 June 1944 Assignment MR 6-15
 Study Prepared by: Omaha, Nebr. District
Missouri River Division

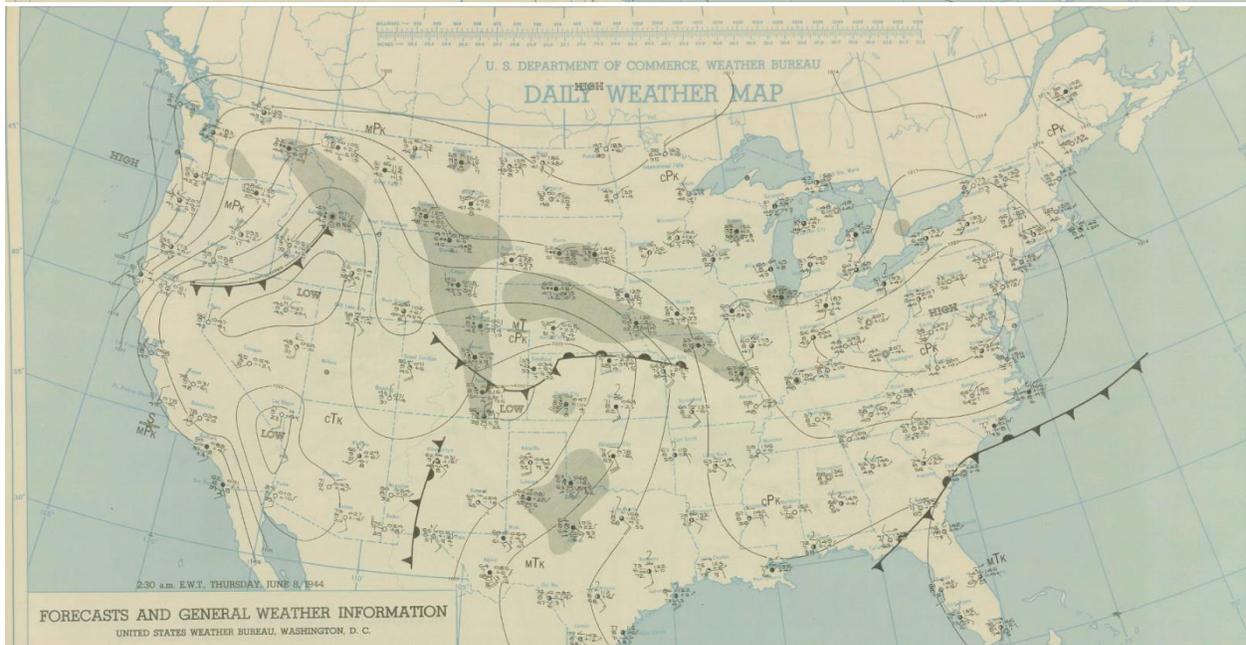
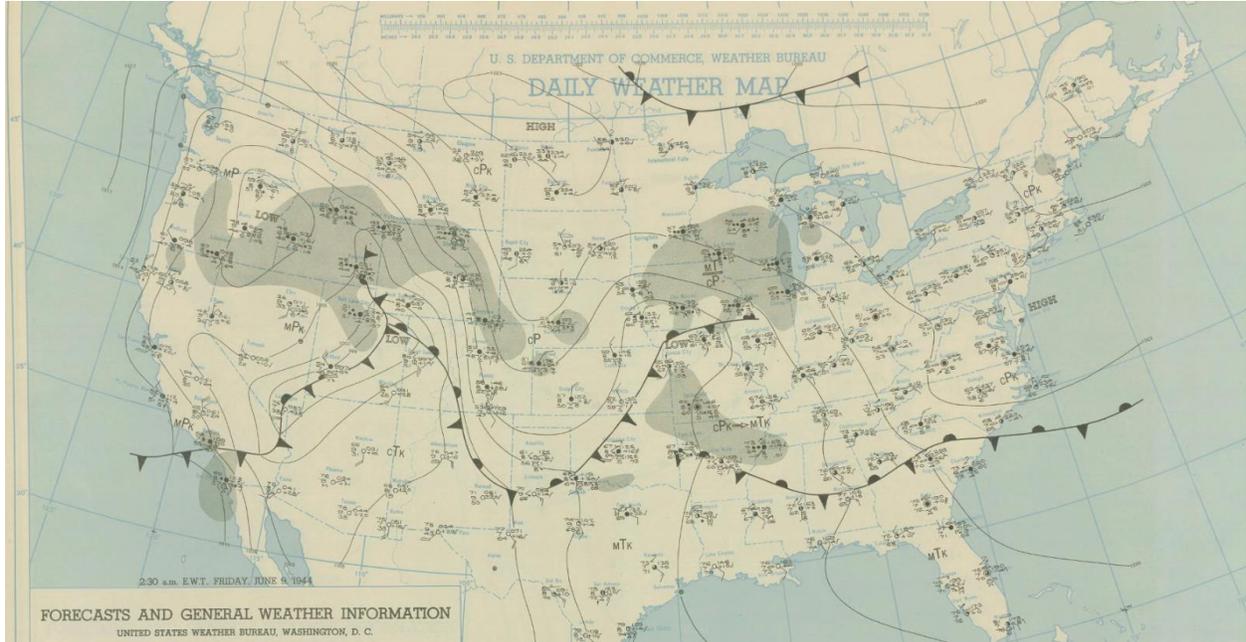


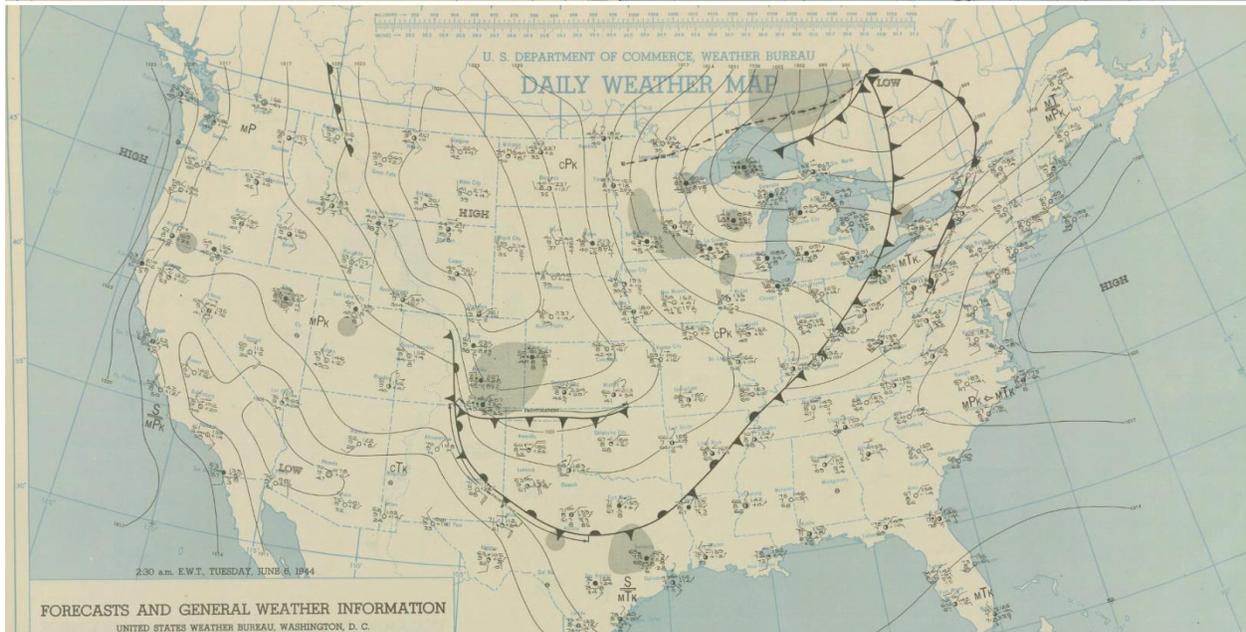
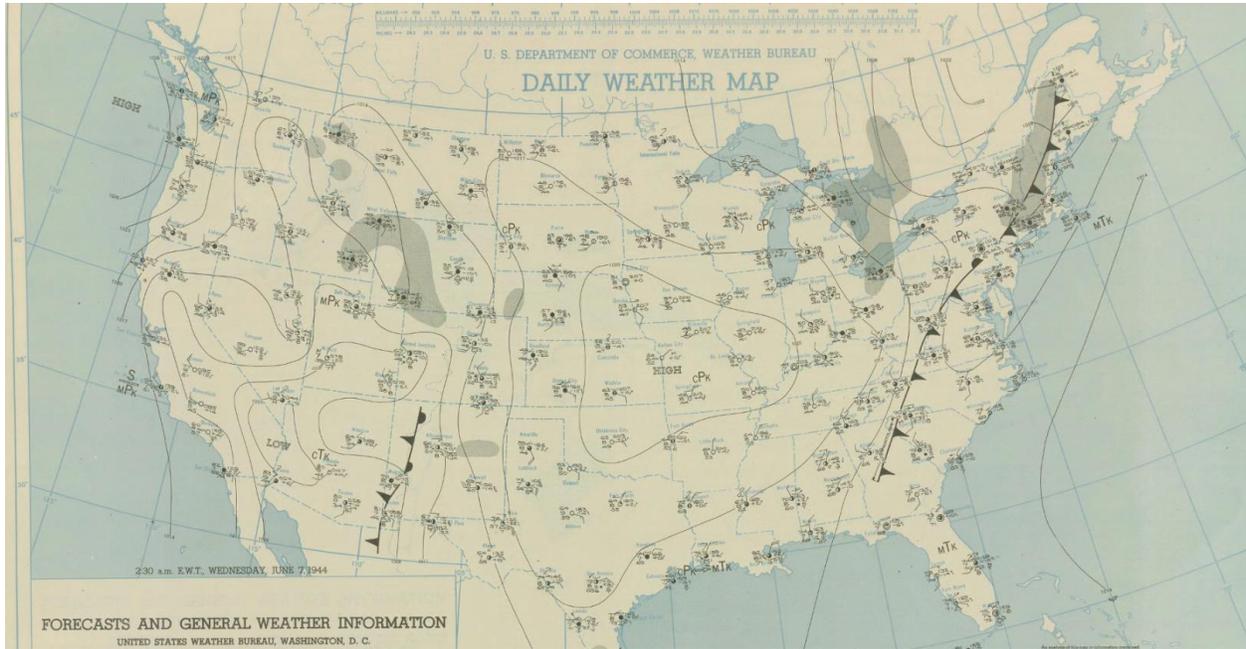
MASS RAINFALL CURVES

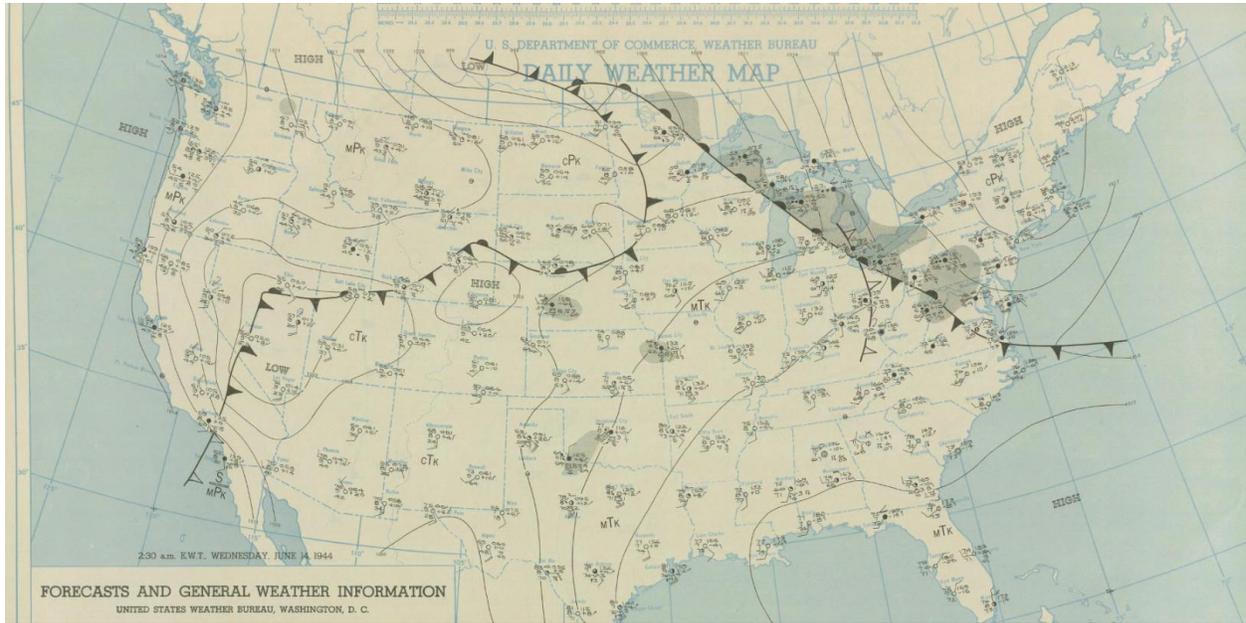




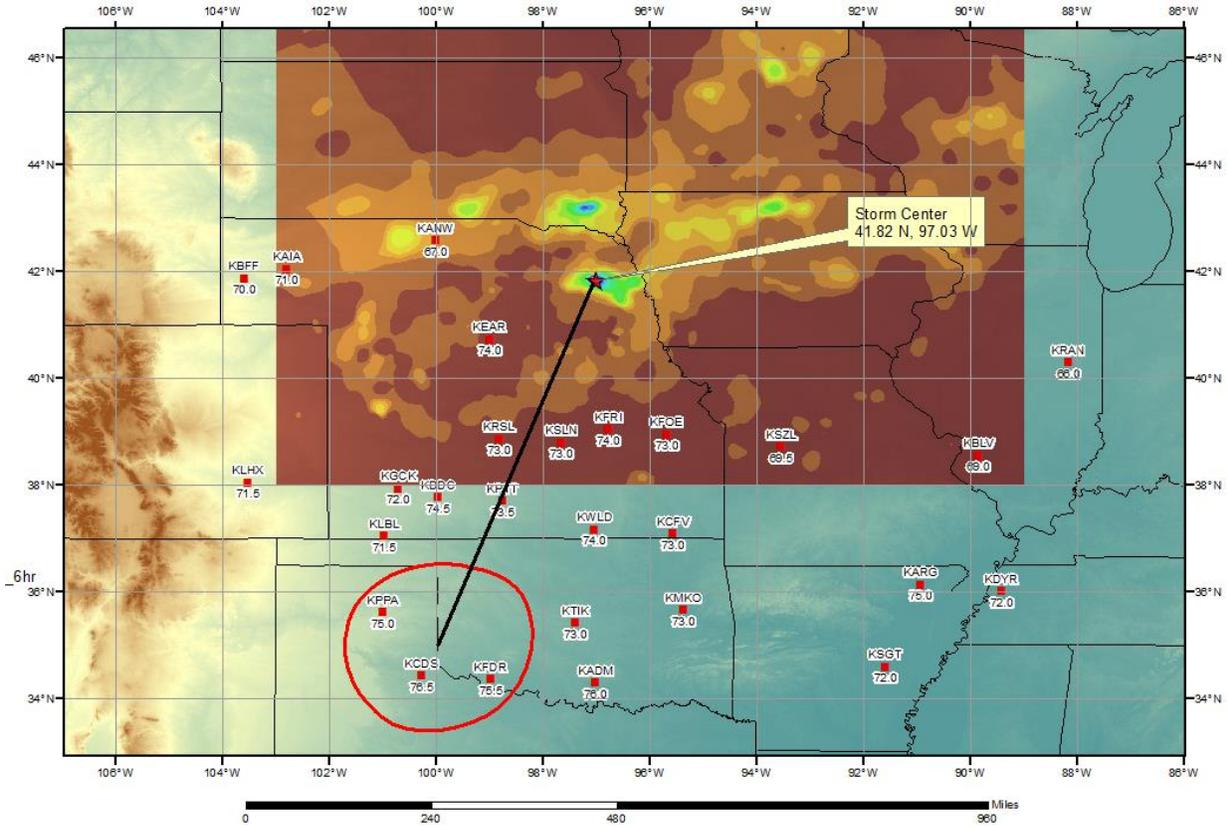








SPAS 1736 Storm Analysis June 9-10, 1944



Storm Precipitation Analysis System (SPAS) For Storm #1434_1 SPAS Analysis

General Storm Location: Holt, Missouri

Storm Dates: June 18 – June 23, 1947

Event: CORPS of Engineers, US Army Assignment MR 8 – 20

DAD Zone 1

Latitude: 39.4542

Longitude: -94.3292

Max. Grid Rainfall Amount: 17.62"

Max. Observed Rainfall Amount: 17.62"

Number of Stations: 162

SPAS Version: 10.0

Basemap: Manually digitized contours using Army CORPS of Engineers isohyetal map.

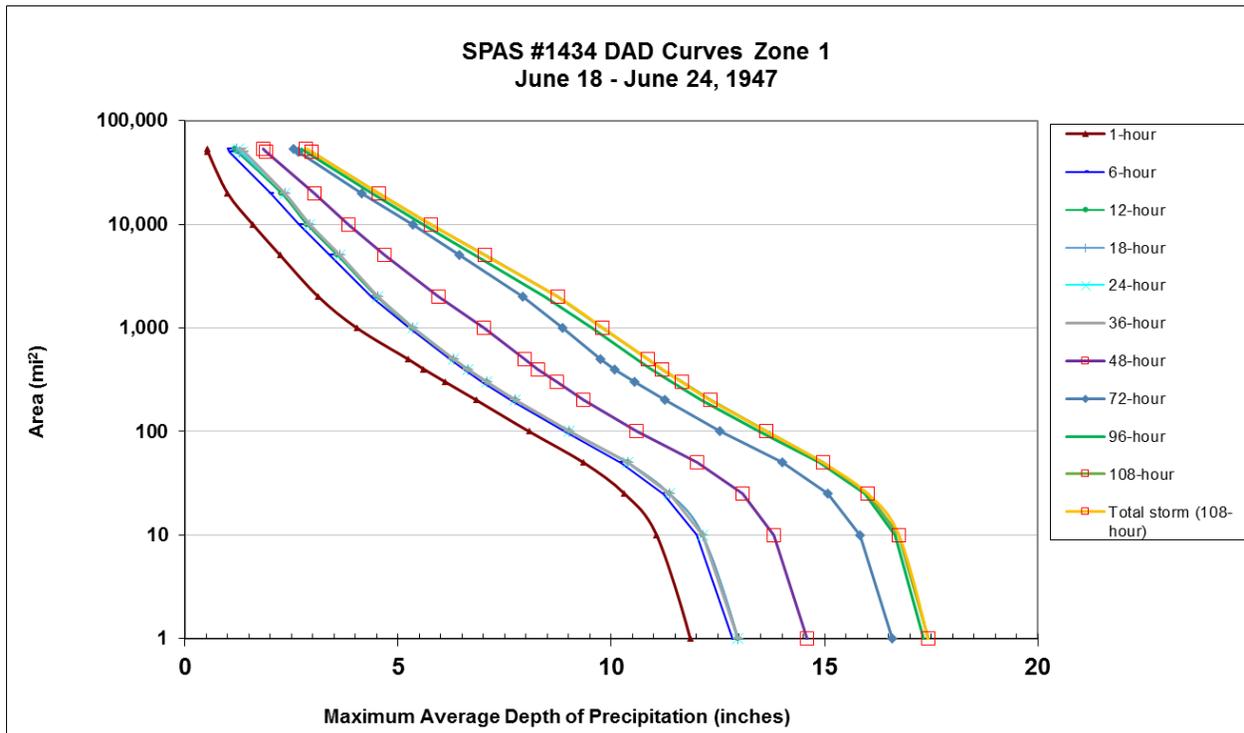
Spatial resolution: 0.2548

Radar Included: No

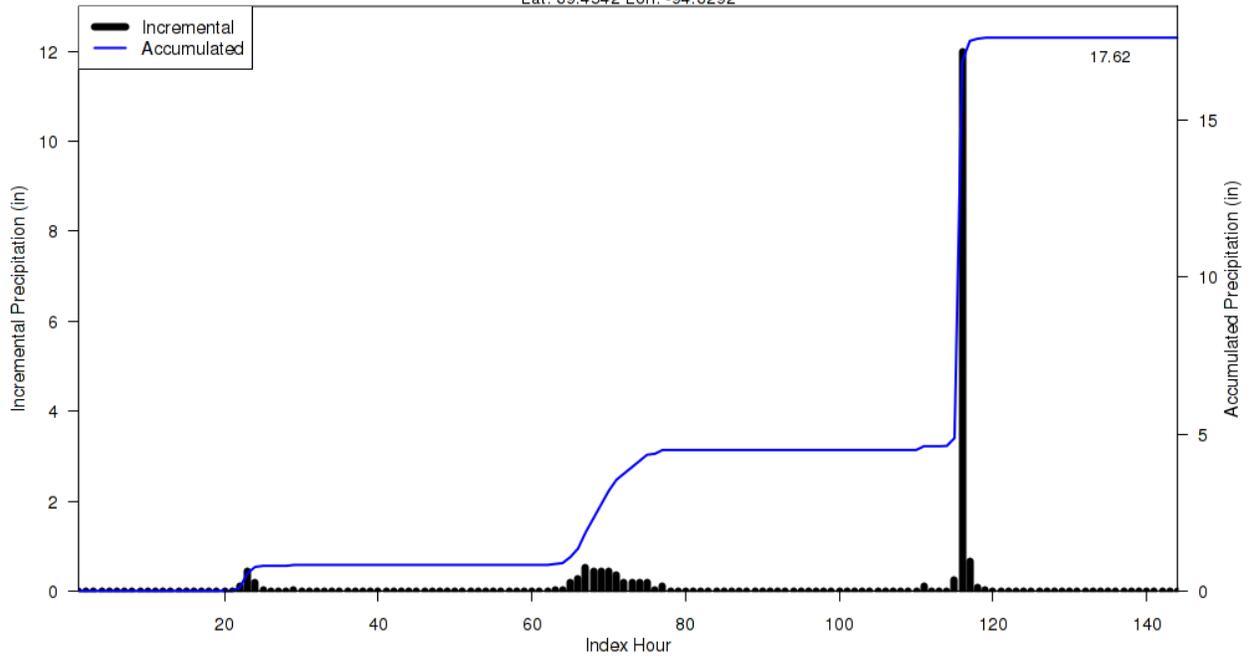
Depth-Area-Duration (DAD) analysis: Yes

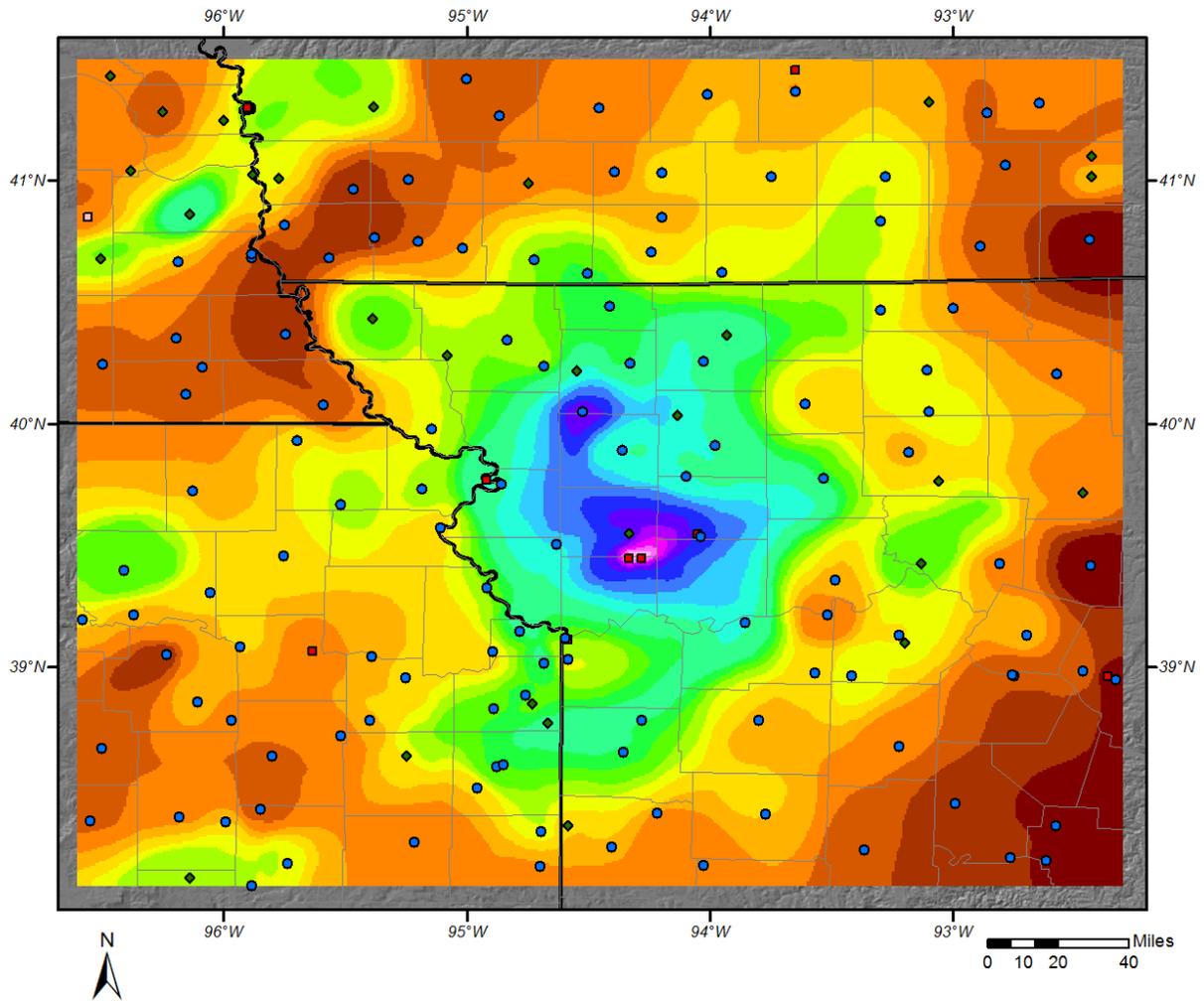
Reliability of results: Ten of the eleven hourly stations used in this analysis were manually digitized from either the Army CORPS of Engineers' pertinent data report or from local climatological data. The last hourly station was estimated from the spas precipitation grid due to daily and supplemental stations nearby needing more accurate timing. This provided very high accuracy of the hourly data, which is essential in the timing of the daily and supplemental stations. Of the 28 supplemental stations, 8 were formatted as daily stations. These stations were in the supplemental file due to there being more data on either end of the storm duration as defined for this analysis. For example, if the daily station took measurements in the morning, then there may have been more precipitation reported for the remainder of the storm that was actually part of the following day's observation. Alternatively, if a station had an observation time in the evening then there could have been data not used from the day before that was valid for the period of the storm and could be added to the analysis. An additional 8 stations found in the CORPS report were added to the supplemental file as well. With all of the data being thoroughly inspected, the DAD and precipitation pattern following closely to the Army CORPS of Engineers report, and the precipitation totals for various periods throughout the storm being consistent with previous reports, this analysis is considered to be reliable.

Storm 1434 - June 18 (0700 UTC) - June 24 (0600 UTC), 1947											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
Area (mi ²)	Duration (hours)										
	1	6	12	18	24	36	48	72	96	108	Total
0.4	11.95	12.96	13.08	13.08	13.08	13.08	14.71	16.72	17.45	17.55	17.55
1	11.85	12.85	12.97	12.97	12.97	12.97	14.59	16.58	17.31	17.42	17.42
10	11.06	12.01	12.14	12.14	12.14	12.14	13.81	15.84	16.66	16.74	16.74
25	10.31	11.23	11.37	11.37	11.37	11.37	13.08	15.07	15.94	16.01	16.01
50	9.35	10.22	10.38	10.38	10.38	10.38	12.01	14.00	14.87	14.96	14.96
100	8.07	8.91	9.02	9.02	9.02	9.02	10.60	12.55	13.46	13.64	13.64
200	6.84	7.65	7.75	7.75	7.75	7.75	9.35	11.25	12.10	12.32	12.32
300	6.11	6.99	7.09	7.09	7.09	7.09	8.72	10.55	11.41	11.65	11.65
400	5.60	6.54	6.64	6.64	6.64	6.64	8.29	10.09	10.95	11.19	11.19
500	5.23	6.20	6.29	6.30	6.30	6.30	7.97	9.74	10.60	10.85	10.85
1,000	4.03	5.25	5.33	5.35	5.35	5.35	7.01	8.85	9.54	9.80	9.80
2,000	3.13	4.39	4.50	4.53	4.53	4.53	5.95	7.92	8.43	8.74	8.74
5,000	2.24	3.40	3.58	3.63	3.63	3.64	4.69	6.44	6.79	7.04	7.04
10,000	1.59	2.68	2.86	2.93	2.93	2.93	3.84	5.34	5.60	5.77	5.77
20,000	1.00	2.00	2.26	2.34	2.34	2.34	3.03	4.15	4.39	4.54	4.54
50,000	0.54	1.06	1.23	1.28	1.34	1.40	1.90	2.66	2.85	2.97	2.97
53,668	0.52	1.01	1.17	1.22	1.27	1.32	1.83	2.55	2.73	2.85	2.85

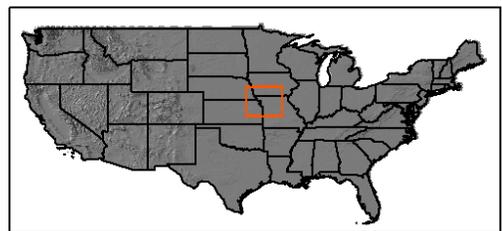
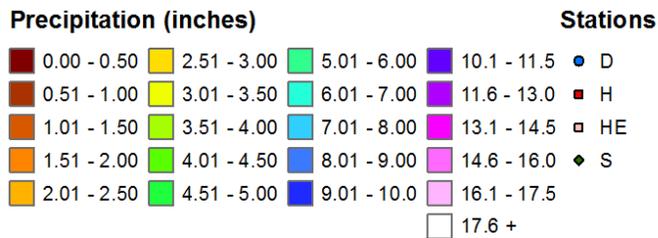


SPAS 1434 Storm Center Mass Curve Zone 1
June 18 (0700UTC) to June 24 (0600UTC), 1947
Lat: 39.4542 Lon: -94.3292

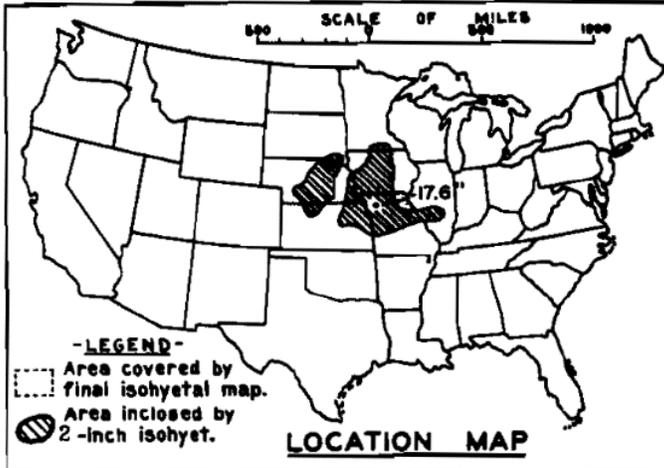




Total 108-hour Precipitation (inches)
June 19, 1947 0000 UTC - June 23, 1947 1200 UTC
SPAS #1434



STORM STUDIES - PERTINENT DATA SHEET



Storm of 18-23 June 1947
 Assignment MR 8-20
 Location Ill., Ia., Kans., Minn., Mo., Nebr. & S.Dak.
 Study Prepared by:
 Missouri River Division
 Omaha District Office

Part I Reviewed by H. M. Sec. of Weather Bureau, 12/17/52
 Part II Approved by Office, Chief of Engineers for Distribution of Factual Data, 9/10/54

Remarks:
 Center near Holt, Mo.
 Dewpoint 75°, Ref. Pt. 140 S

DATA AND COMPUTATIONS COMPILED Grid E-14

PART I

Preliminary isohyetal map, in _____ sheet, scale _____
 Precipitation data and mass curves: _____ (Number of Sheets)
 Form 5001-C (Hourly precip. data) -- NOTE: This study was computed
 Form 5001-B (24-hour " ") ----- by the Regional Method
 Form 5001-D (" " " ") ----- which does not employ the
 Misc. precip. records, meteorological data, etc. Part I and Part II phases
 Form 5002 (Mass rainfall curves) ----- in their entirety.

PART II

Final isohyetal maps, in 1 sheet, scale 1:100,000
 Data and computation sheets:
 Form S-10 (Data from mass rainfall curves) ----- 9
 Form S-11 (Depth-area data from isohyetal map) ----- 4
 Form S-12 (Maximum depth-duration data) ----- 7
 Maximum duration-depth-area curves ----- 1
 Data relating to periods of maximum rainfall -----

MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours									
	6	12	18	24	36	48	72	96	120	
Max. Station	12.0	12.0	12.0	12.0	12.0	14.4	16.6	18.8	17.6	
10	11.5	11.5	11.5	11.5	11.5	12.6	15.8	15.8	16.9	
100	7.9	7.9	7.9	7.9	7.9	9.3	12.9	12.9	14.1	
200	7.1	7.1	7.1	7.1	7.1	8.4	11.9	11.9	13.0	
500	6.3	6.3	6.3	6.3	6.3	7.4	10.6	10.6	11.6	
1000	5.6	5.6	5.6	5.6	5.6	6.6	9.6	9.6	10.5	
2000	4.9	4.9	4.9	4.9	4.9	5.7	8.4	8.4	9.3	
5000	3.5	3.7	3.7	3.7	3.7	4.6	6.7	6.7	7.3	
10000	2.6	2.9	3.0	3.0	3.0	3.7	5.4	5.4	5.9	
20000	1.8	2.1	2.2	2.2	2.2	3.1	4.4	4.6	4.9	
50000	1.2	1.4	1.5	1.6	1.6	2.5	3.2	3.5	3.8	
100000	0.8	1.0	1.1	1.2	1.2	2.1	2.7	2.9	3.0	
200000	0.6	0.7	0.8	0.9	0.9	1.7	2.1	2.2	2.3	
308000	0.5	0.5	0.6	0.7	0.7	1.2	1.5	1.6	1.6	

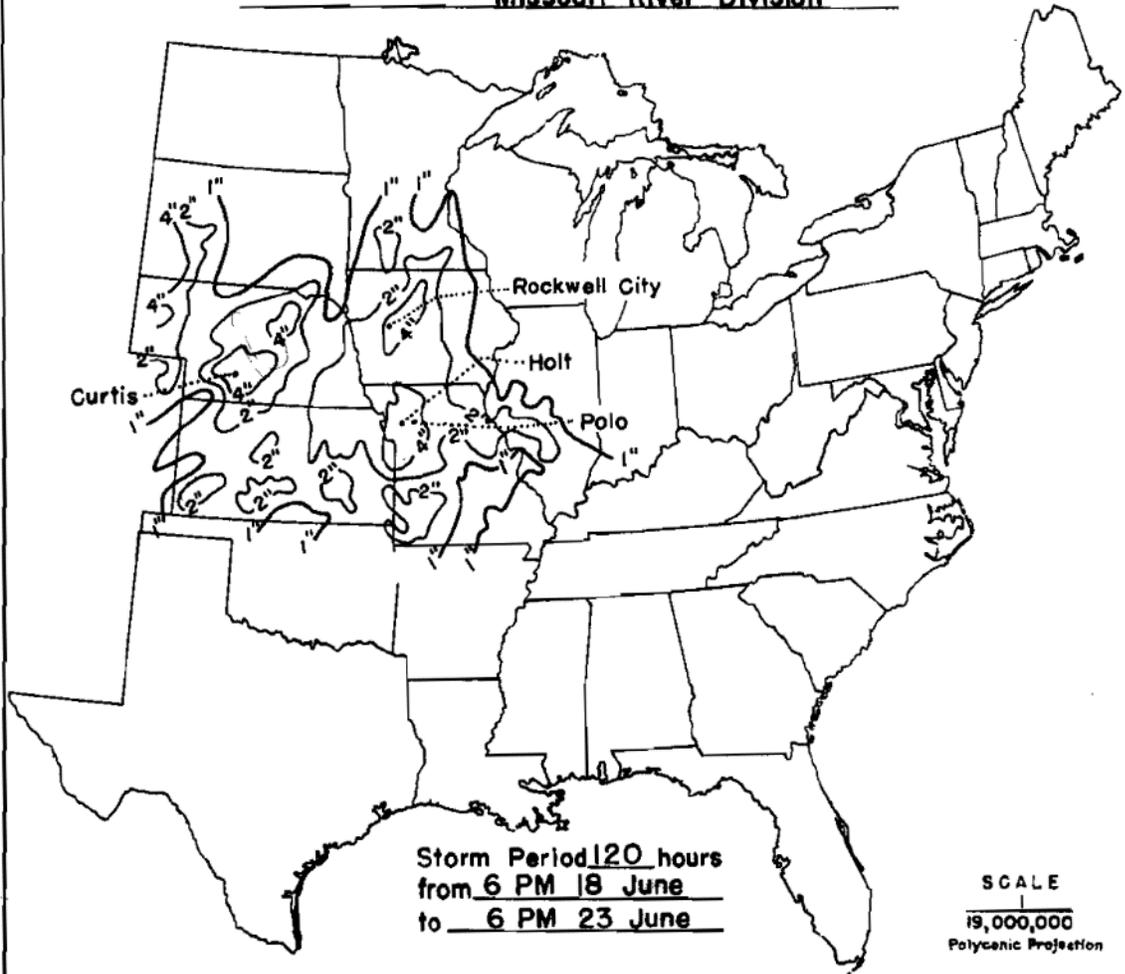
DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

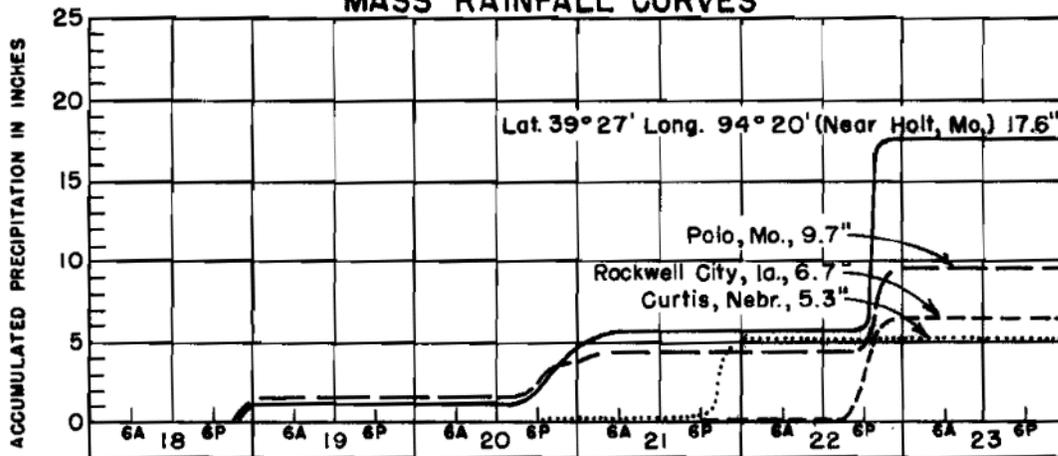
STORM STUDIES - ISOHYETAL MAP

Storm of 18-23 June 1947 Assignment MR 8-20

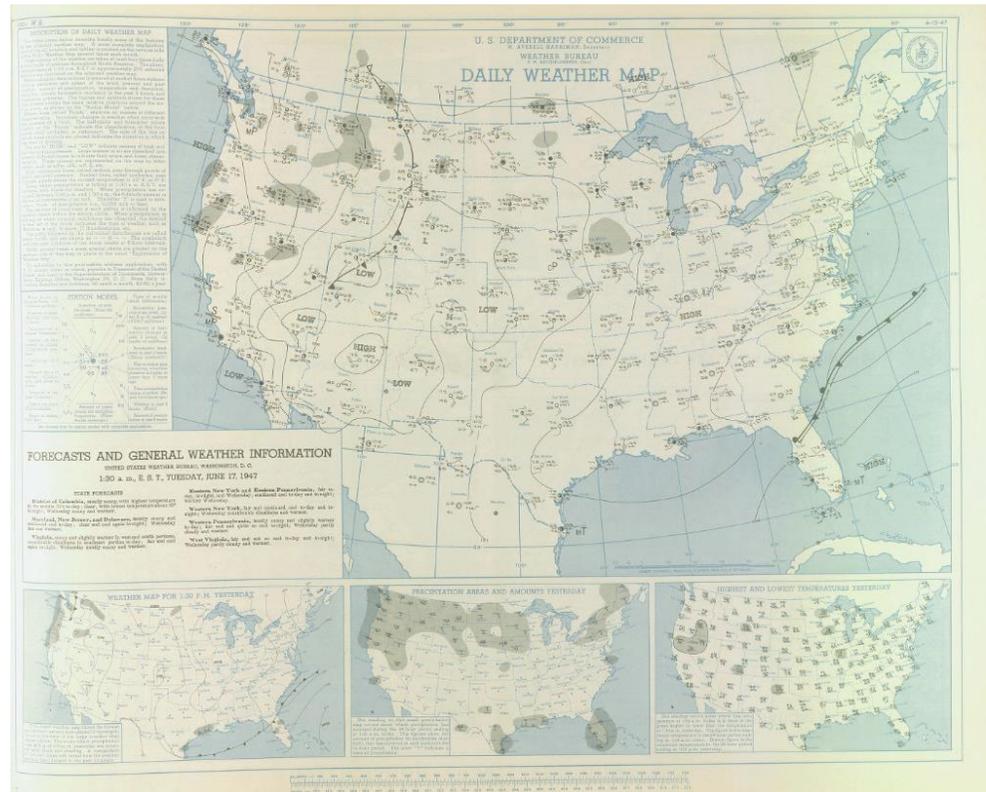
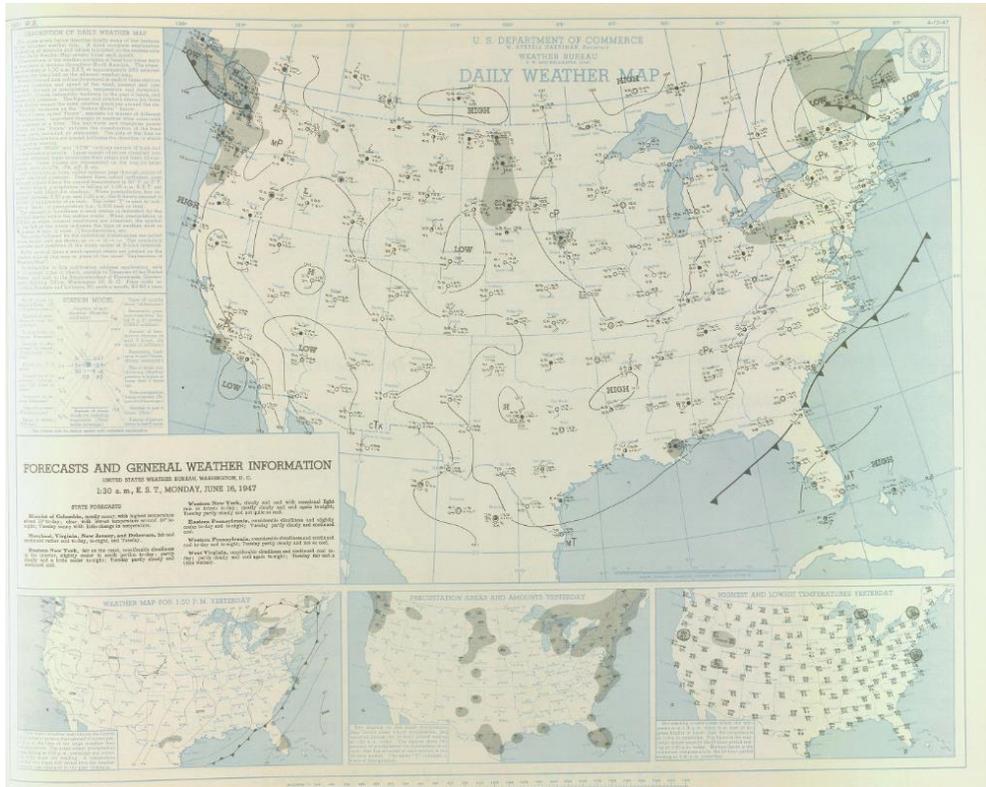
Study Prepared by: Omaha, Nebr., District
Missouri River Division

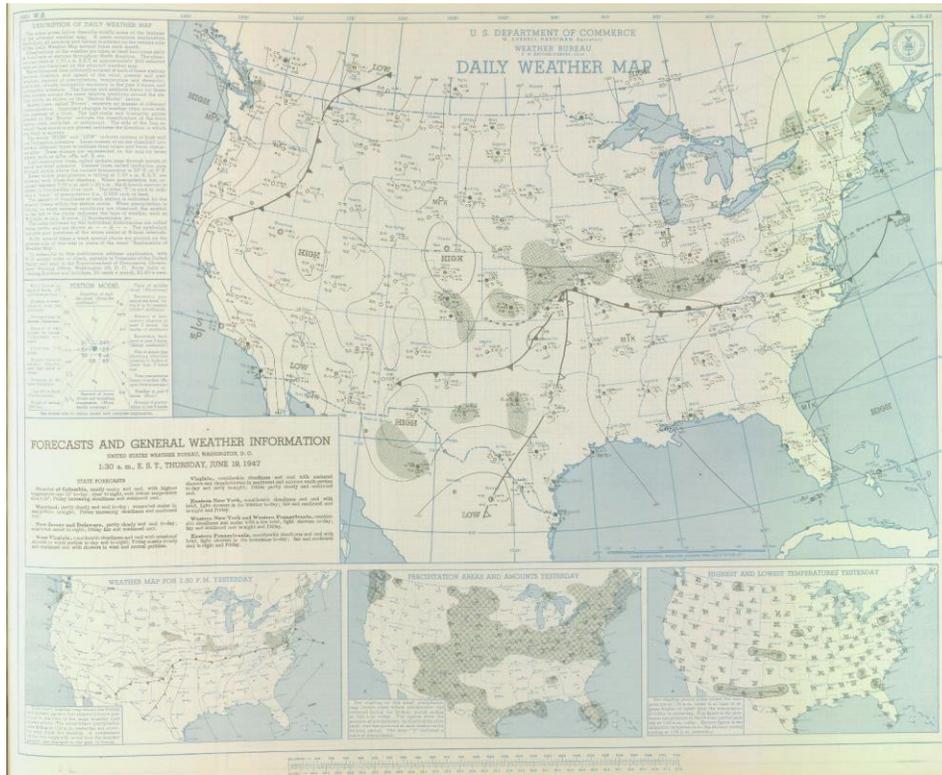
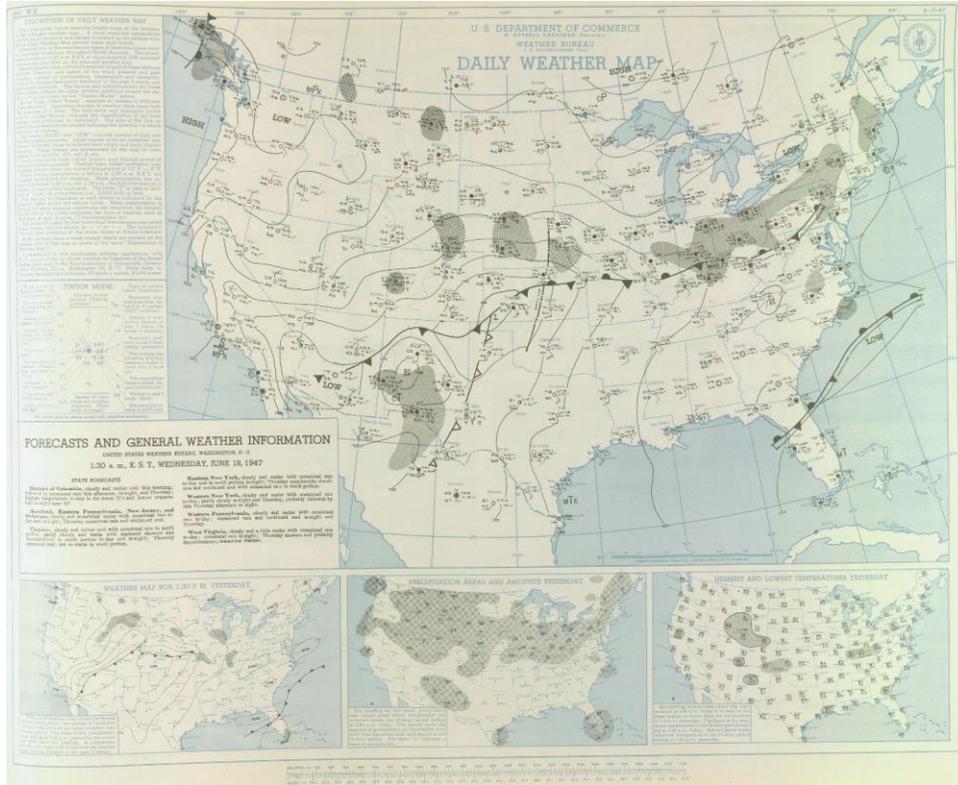


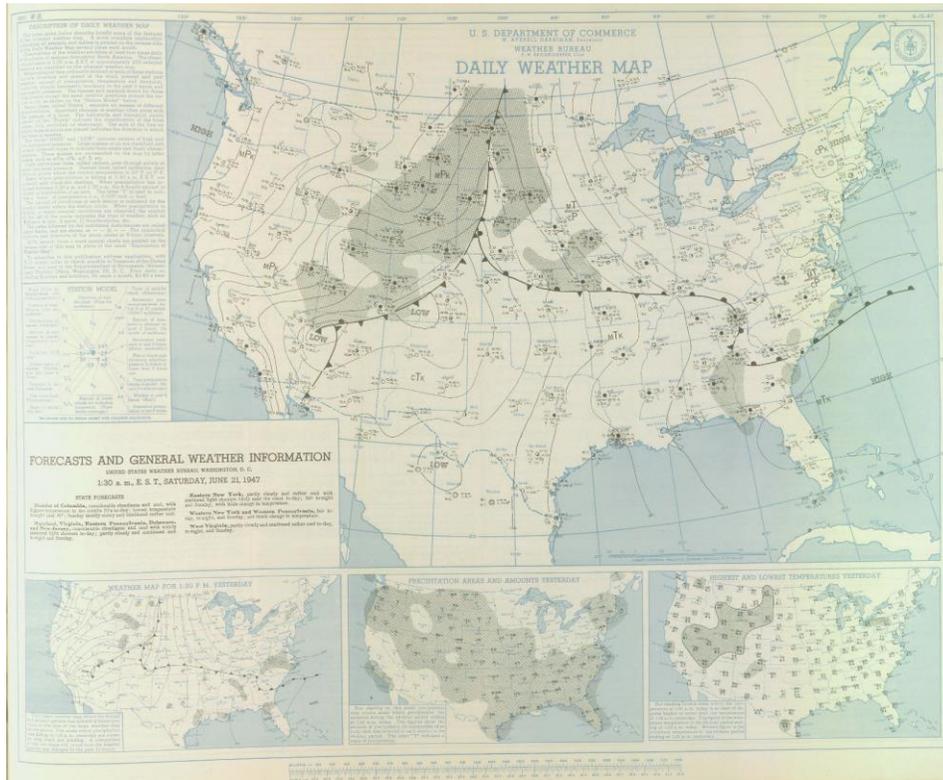
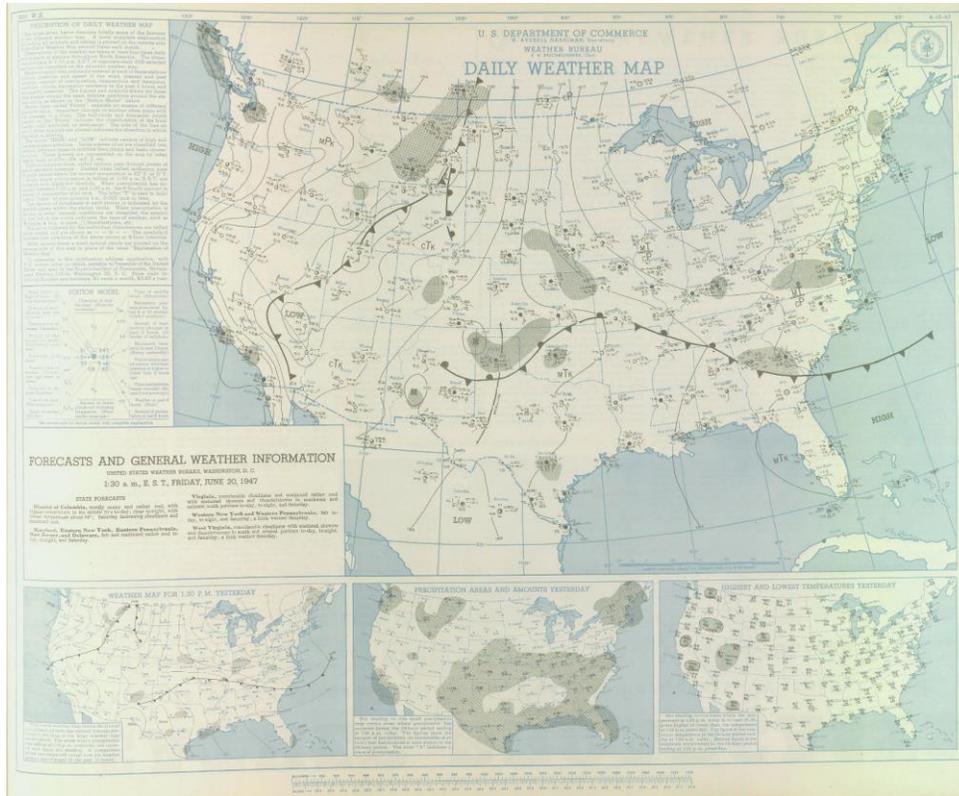
MASS RAINFALL CURVES

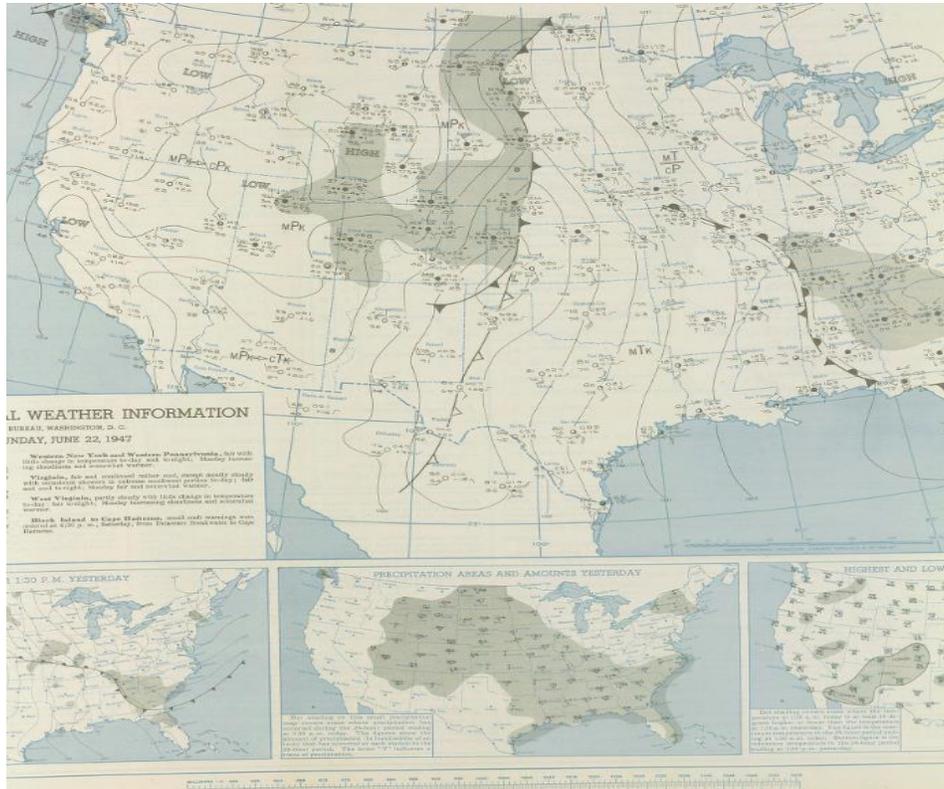


FORM 8-3E

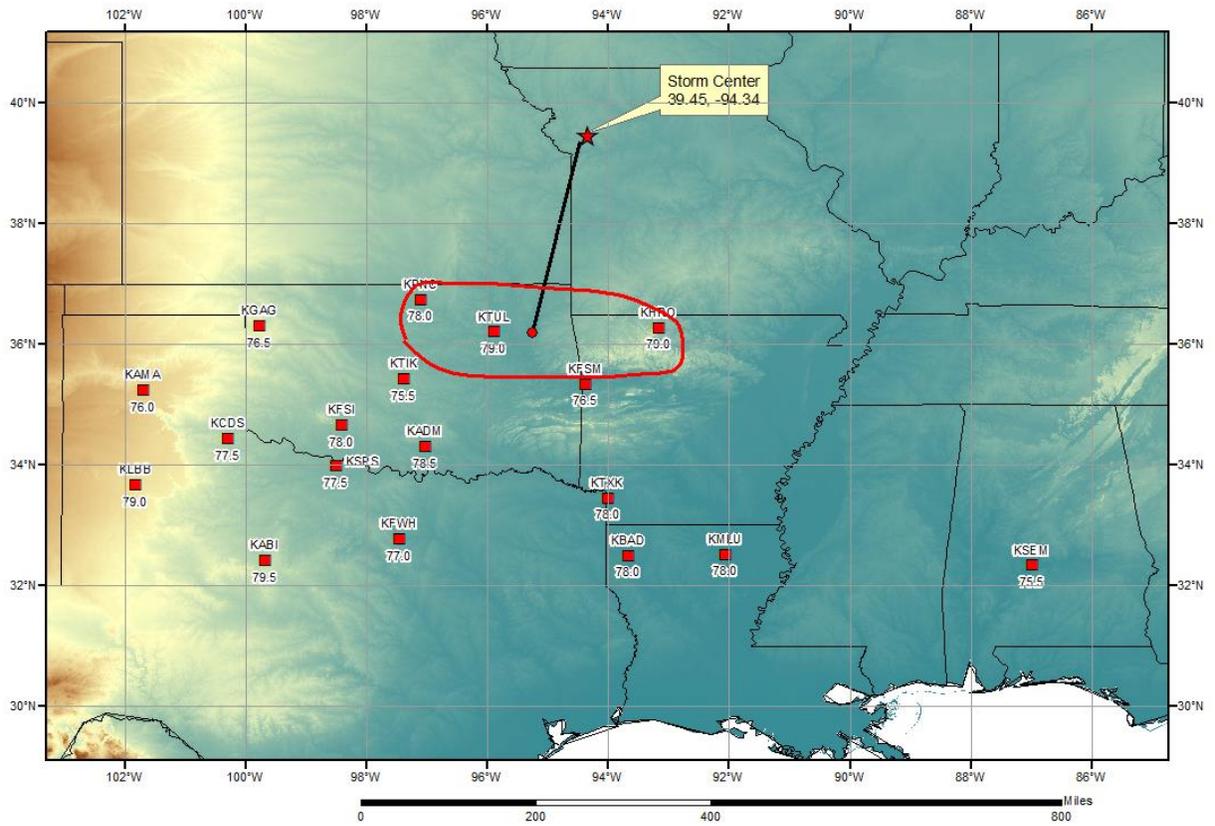








Holt, MO Storm Analysis June 19-23, 1947



Storm Precipitation Analysis System (SPAS) For Storm #1734_1 SPAS Analysis

General Storm Location: Thief River, MN

Storm Dates: May 27-31, 1949

Event: Local

DAD Zone 1

Latitude: 48.1625

Longitude: -96.2625

Max. Grid/Radar Rainfall Amount: 9.96"

Max. Observed Rainfall Amount: 9.59"

Number of Stations: 271

SPAS Version: 10.0

Base Map Used: Blend of PRISM climatology and usda basemap

Spatial resolution: 0.2242

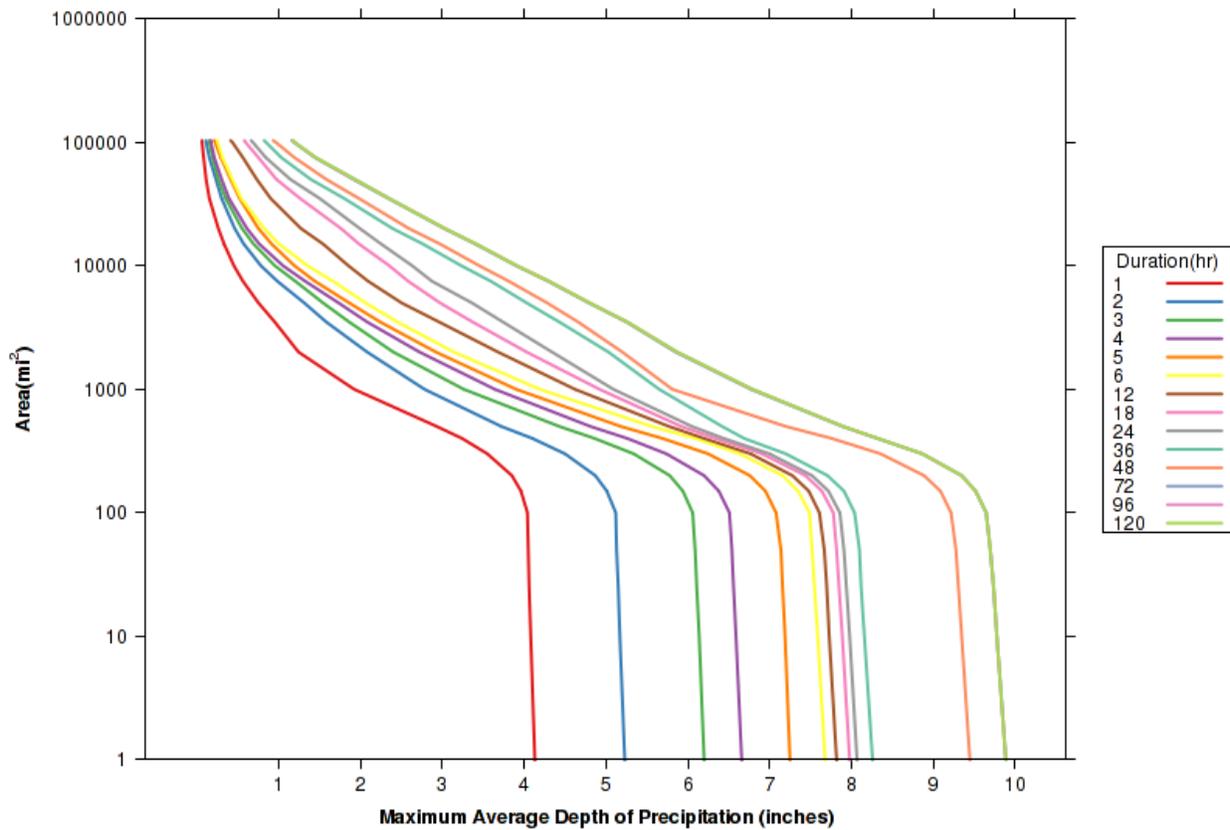
Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes

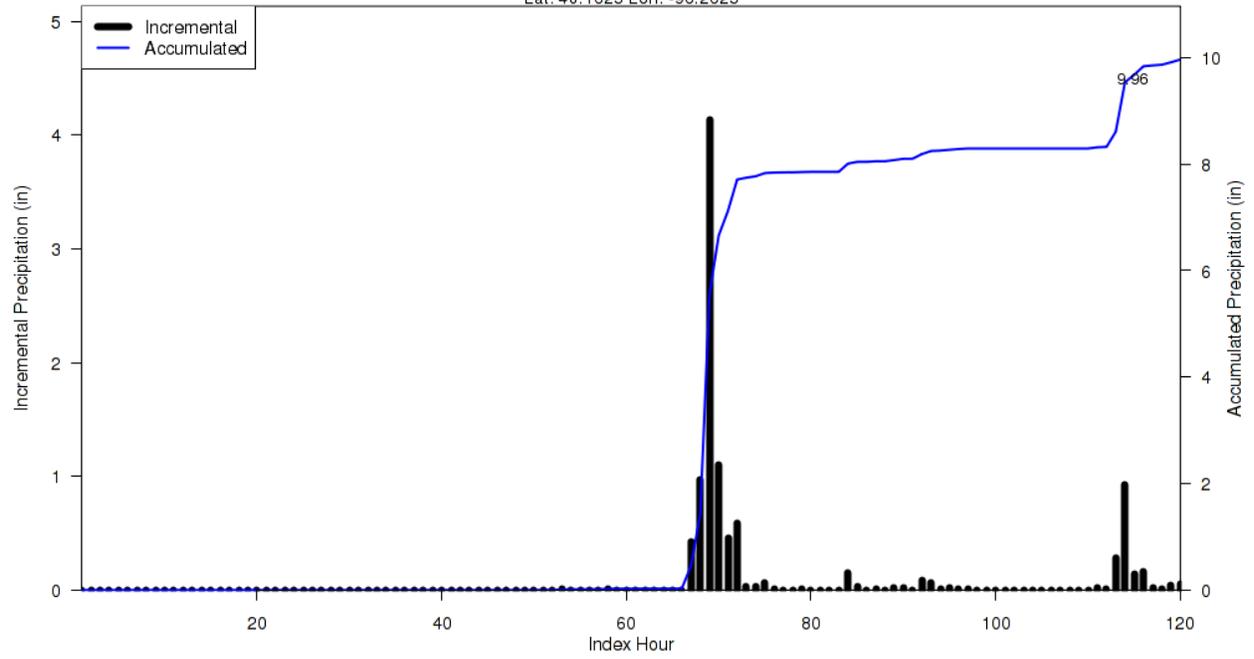
Reliability of Results: This analysis was based on 271 hourly stations, daily data, and supplemental station data. We have a good degree of confidence for the station based storm total results. The spatial pattern is fully dependent on the blended basemap. Timing is based on the hourly and hourly pseudo stations. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

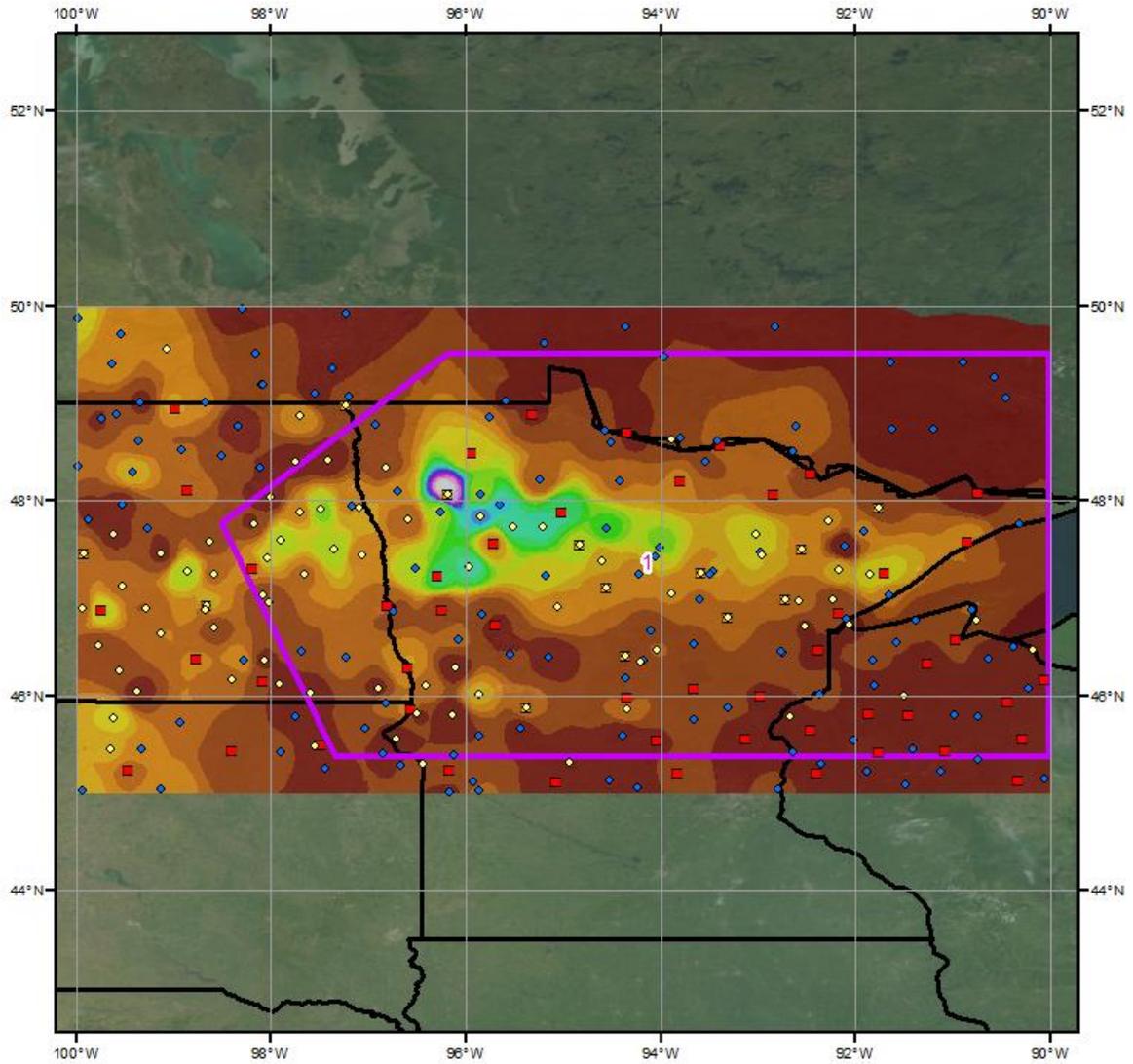
Storm 1734 - May 27 (0600 UTC) - June 1 (0500 UTC), 1949															
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)															
Area (mi ²)	Duration (hours)														
	1	2	3	4	5	6	12	18	24	36	48	72	96	120	Total
0.4	4.15	5.25	6.23	6.69	7.28	7.72	7.85	8.01	8.11	8.29	9.49	9.94	9.94	9.94	9.94
1	4.13	5.23	6.20	6.66	7.25	7.68	7.82	7.98	8.07	8.26	9.45	9.89	9.89	9.89	9.89
10	4.08	5.17	6.14	6.59	7.19	7.59	7.73	7.89	7.98	8.16	9.35	9.78	9.78	9.78	9.78
25	4.06	5.15	6.11	6.56	7.16	7.55	7.70	7.85	7.94	8.12	9.31	9.74	9.74	9.74	9.74
50	4.05	5.13	6.09	6.54	7.14	7.52	7.67	7.82	7.91	8.10	9.28	9.70	9.70	9.70	9.70
100	4.04	5.12	6.06	6.51	7.08	7.49	7.61	7.78	7.86	8.04	9.22	9.65	9.65	9.65	9.65
200	3.85	4.87	5.78	6.20	6.76	7.16	7.28	7.44	7.52	7.71	8.89	9.35	9.35	9.35	9.35
300	3.55	4.50	5.34	5.74	6.25	6.64	6.77	6.91	7.00	7.20	8.36	8.87	8.87	8.87	8.87
400	3.24	4.10	4.86	5.26	5.69	6.09	6.20	6.34	6.44	6.69	7.76	8.32	8.32	8.32	8.32
500	2.93	3.72	4.43	4.81	5.18	5.56	5.77	5.92	6.05	6.42	7.20	7.89	7.90	7.90	7.90
1,000	1.92	2.78	3.26	3.64	3.90	4.19	4.62	4.92	5.09	5.65	5.81	6.77	6.79	6.79	6.79
2,000	1.24	2.08	2.40	2.72	2.92	3.14	3.68	4.03	4.34	5.03	5.20	5.85	5.87	5.87	5.87
5,000	0.75	1.31	1.54	1.73	1.86	2.06	2.50	2.97	3.36	4.03	4.28	4.79	4.80	4.80	4.80
10,000	0.45	0.78	0.95	1.05	1.19	1.35	1.85	2.35	2.63	3.23	3.45	3.90	3.91	3.91	3.91
20,000	0.26	0.46	0.55	0.61	0.75	0.82	1.27	1.76	1.99	2.39	2.59	3.02	3.03	3.03	3.03
50,000	0.11	0.23	0.26	0.30	0.41	0.43	0.73	0.97	1.14	1.39	1.58	1.91	1.93	1.93	1.93
100,000	0.06	0.11	0.15	0.17	0.22	0.25	0.43	0.59	0.68	0.84	0.96	1.18	1.19	1.19	1.19

SPAS 1734 DAD Curves Zone 1
May 27 (0600UTC) to June 1 (0500UTC), 1949



SPAS 1734 Storm Center Mass Curve Zone 1
May 27 (0600UTC) to June 1 (0500UTC), 1949
Lat: 48.1625 Lon: -96.2625





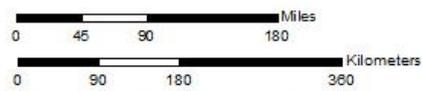
Total Storm (120-hours) Precipitation (inches)

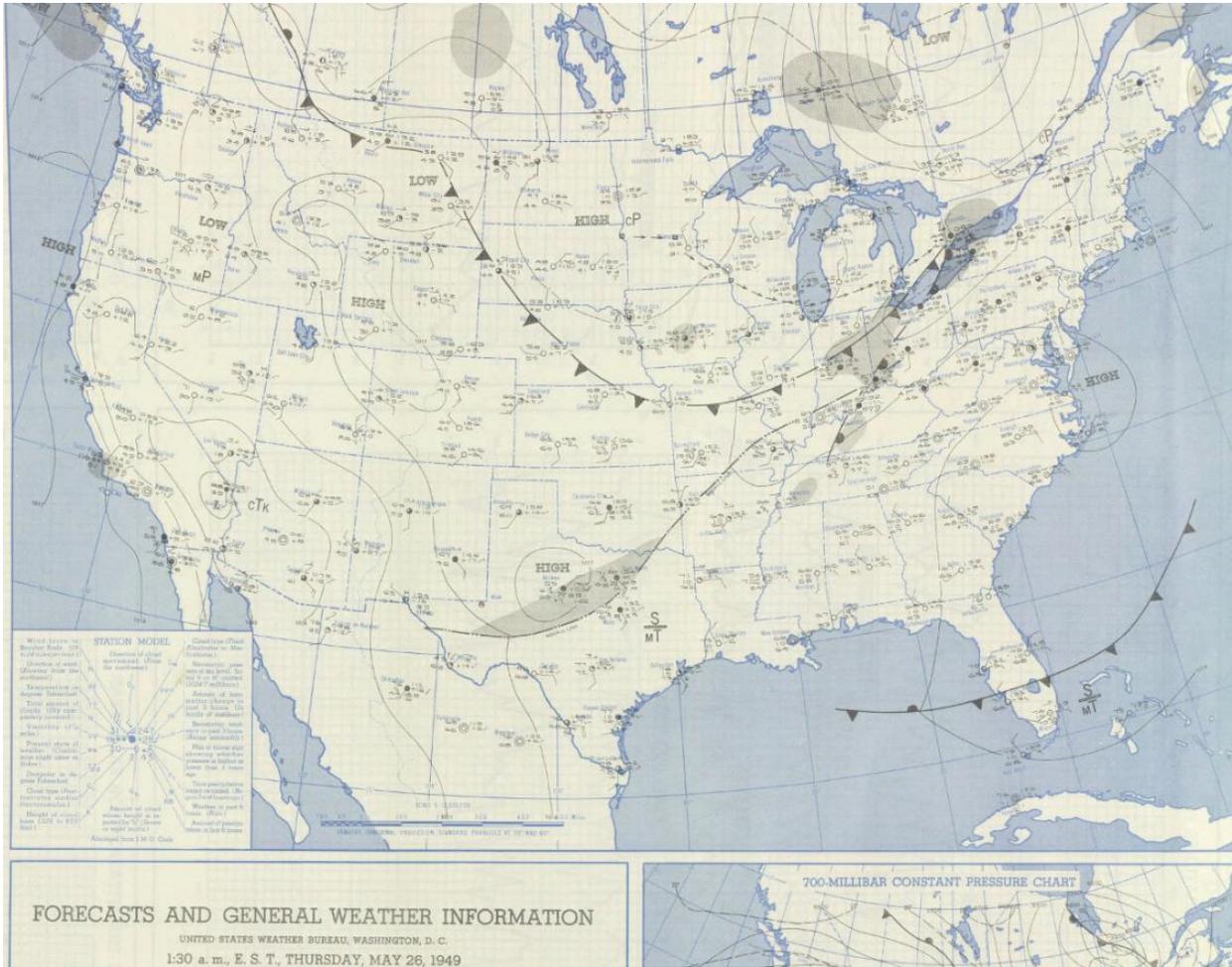
May 27-31, 1949

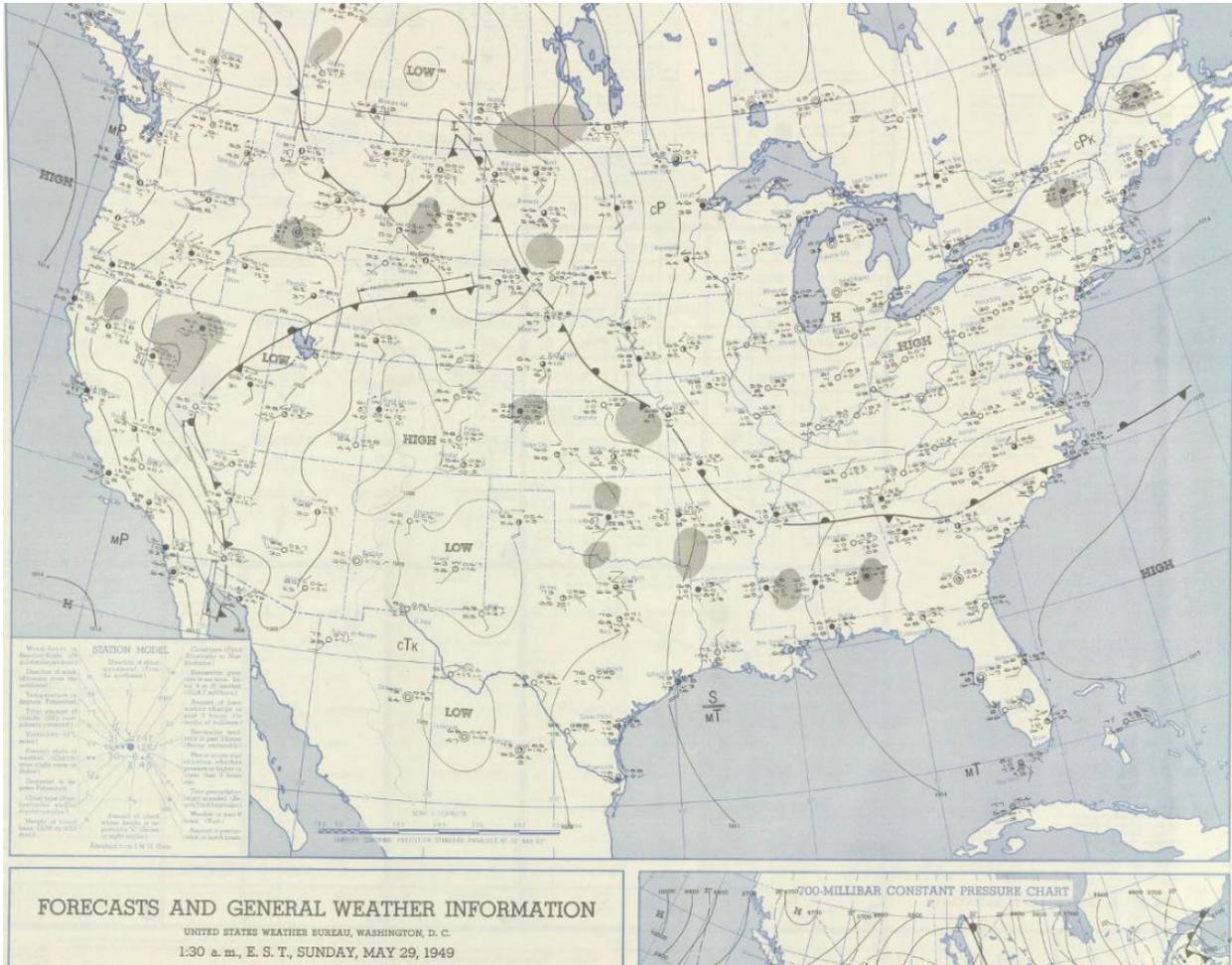
SPAS 1734 - Thief River, MN

Gauges

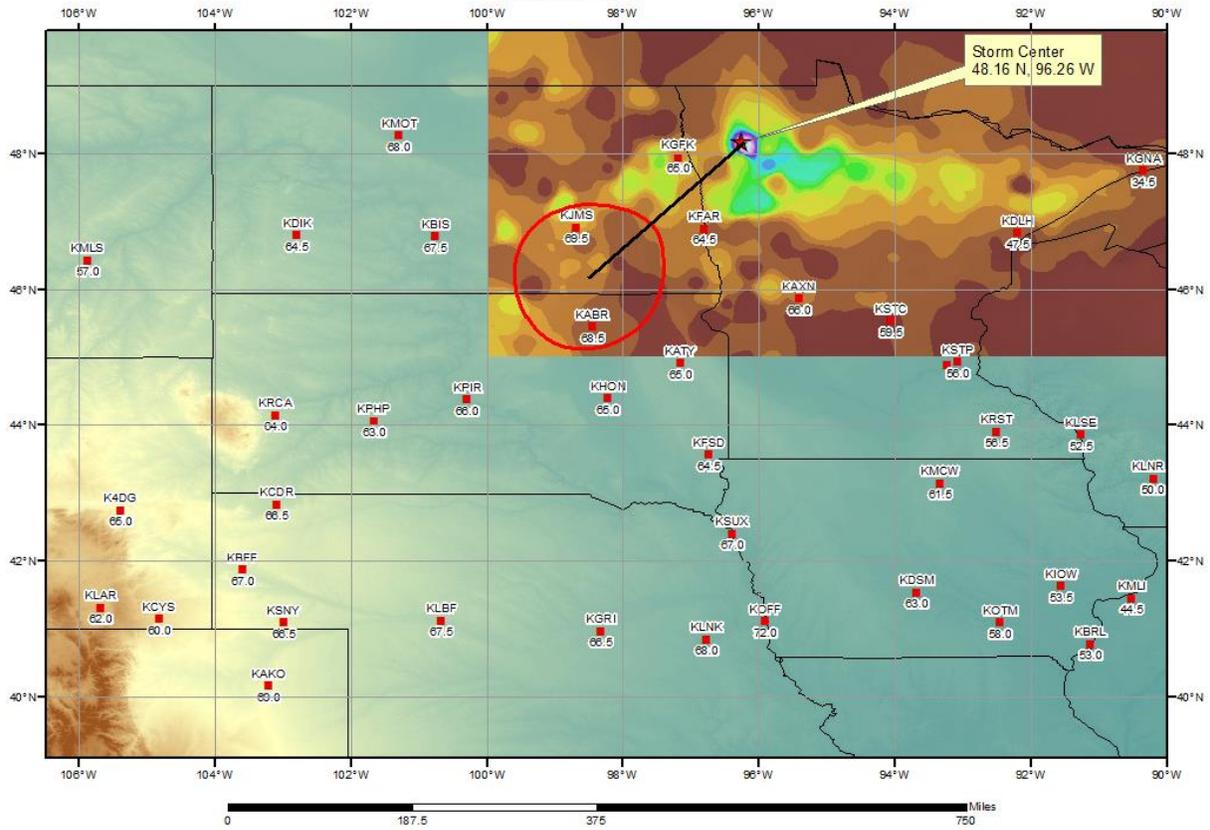
- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental
- ◆ SE







SPAS 1734 Storm Analysis May 29, 1949



Storm Precipitation Analysis System (SPAS) For Storm #1334_1 SPAS Analysis

General Storm Location: Buffalo Gap, Saskatchewan, Canada (just north of Montana)

Storm Dates: May 30, 1961

Event: Severe convective thunderstorm

DAD Zone 1

Latitude: 49.1146°

Longitude: -105.2896°

Max. grid rainfall amount: 267mm

Max. observed rainfall amount: 267mm (near BUFFALO GAP, SK, CANADA)

Number of Stations: 22

SPAS Version: 9.5

Base Map Used: Based on digitized Canadian Climate Centre of Environment Canada Isohyetal Map (storm total)

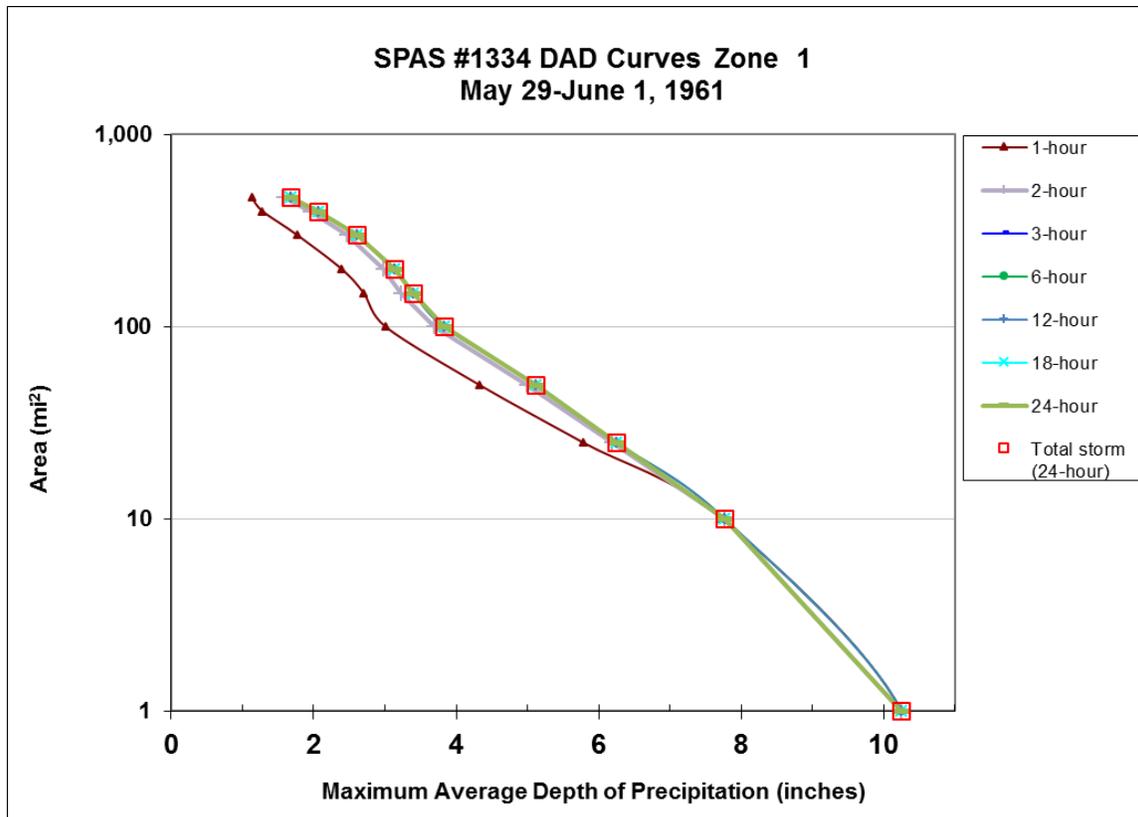
Spatial resolution: 15 seconds (degree: minute: second, WGS84, ~ 0.1 mi², 0.26 km²)

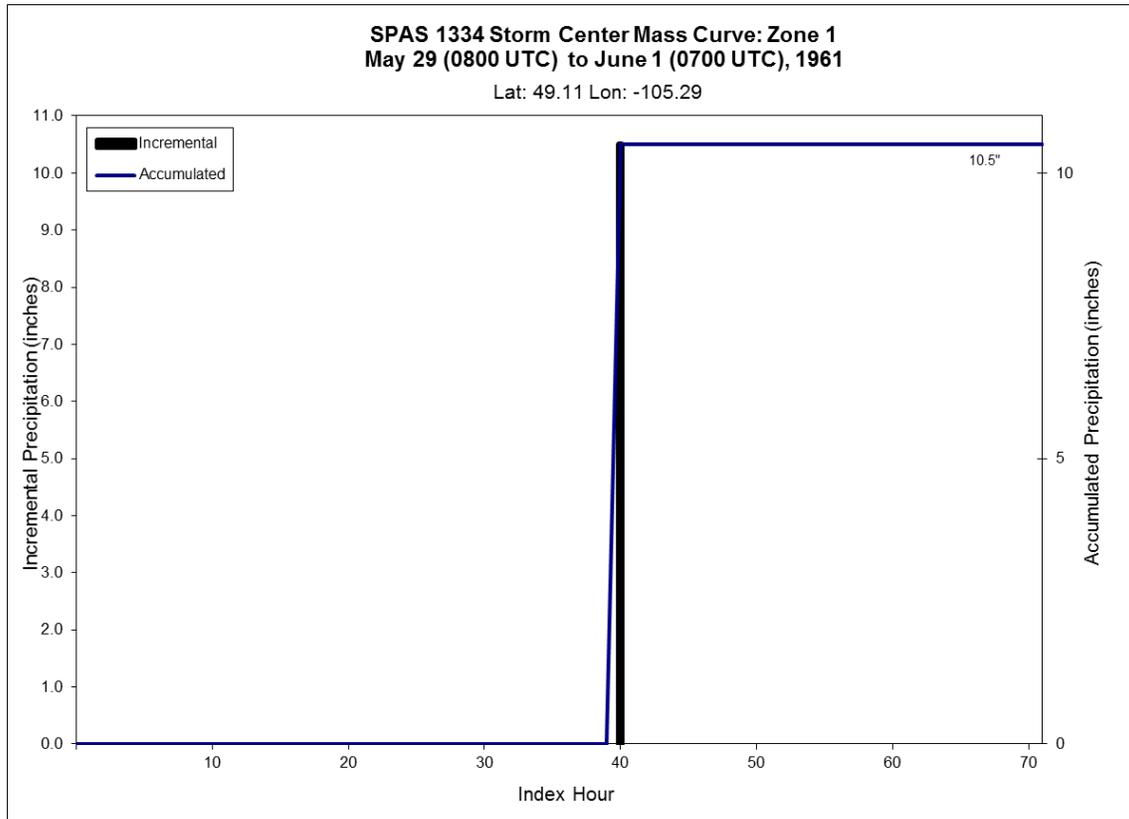
Radar Included: No

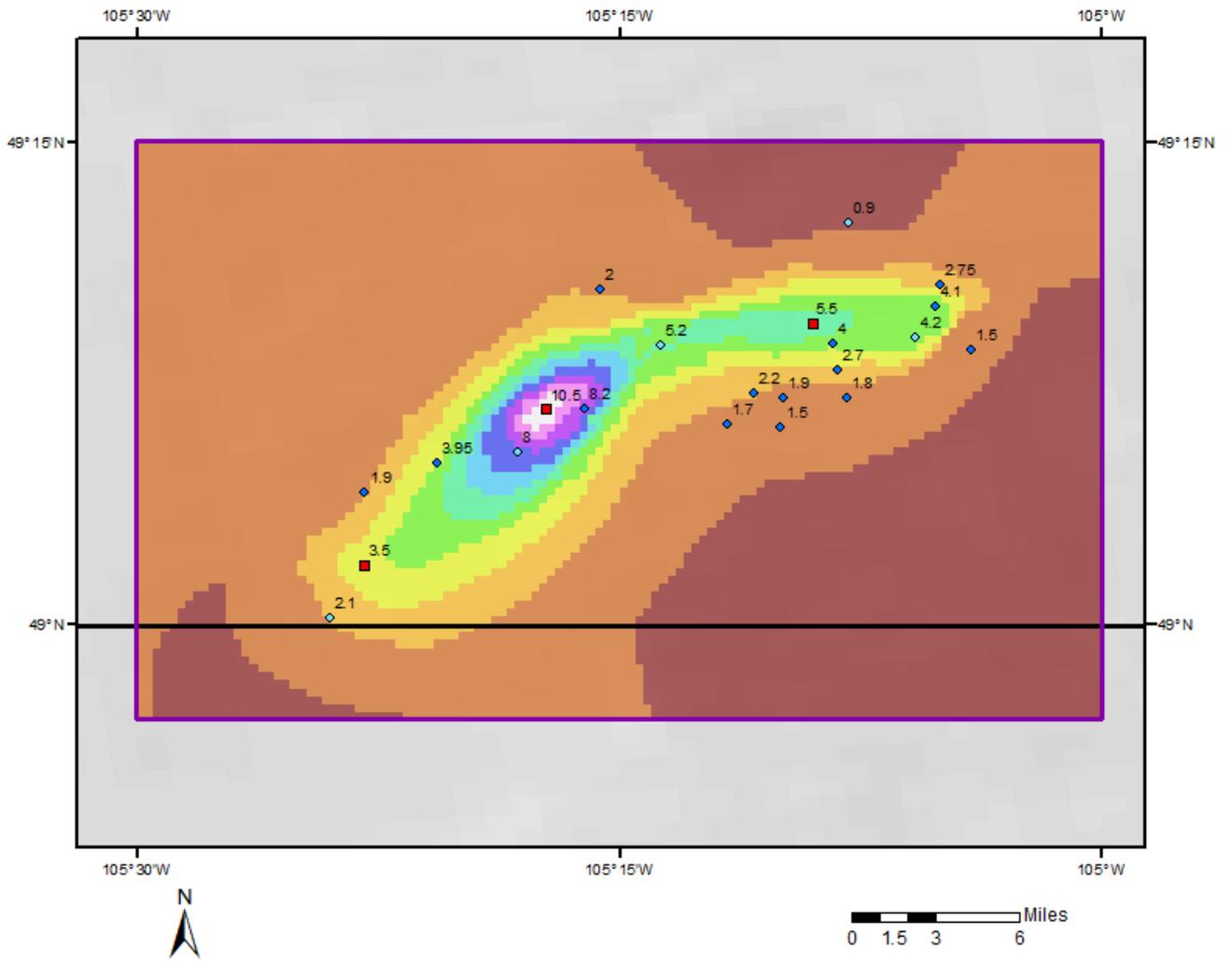
Depth-Area-Duration (DAD) analysis: Yes

Reliability of Results: There were no recording gauges and a great deal of estimation was employed at all stations which ranged from standard size gauges, small orifice gauges, bucket measurements and straight estimation. The storm also consisted of high winds and heavy hail that could have impacted the rainfall measurements. During the analysis one bucket measurement was removed to improve the spatial pattern in an area with a steep isohyetal gradient but the resulting amount at that location is consistent with observed. This was a very small storm that occurred over only 3 hours. Resulting DADs are consistent with the Environment Canada analysis.

Storm 1334 - May 29 (0900 UTC) - June 1 (0700 UTC), 1961								
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)								
Area (mi ²)	Duration (hours)							
	1	2	3	6	12	18	24	Total
0.1	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50
1	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25
10	7.73	7.77	7.77	7.77	7.77	7.77	7.77	7.77
25	5.78	6.19	6.25	6.25	6.25	6.25	6.25	6.25
50	4.32	4.99	5.11	5.12	5.12	5.12	5.12	5.12
100	3.01	3.69	3.83	3.83	3.83	3.83	3.83	3.83
150	2.70	3.23	3.40	3.40	3.40	3.40	3.40	3.40
200	2.39	2.97	3.13	3.14	3.14	3.14	3.14	3.14
300	1.77	2.46	2.60	2.60	2.60	2.60	2.60	2.60
400	1.28	1.95	2.06	2.06	2.06	2.06	2.06	2.06
470	1.13	1.59	1.68	1.68	1.68	1.68	1.68	1.68



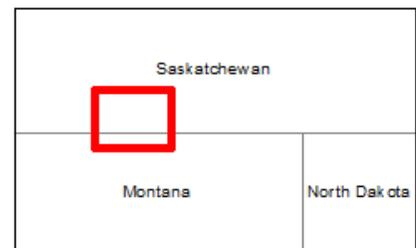




**Total 24-hr Precipitation (inches)
 May 30, 1961 0800 UTC
 SPAS #1334**

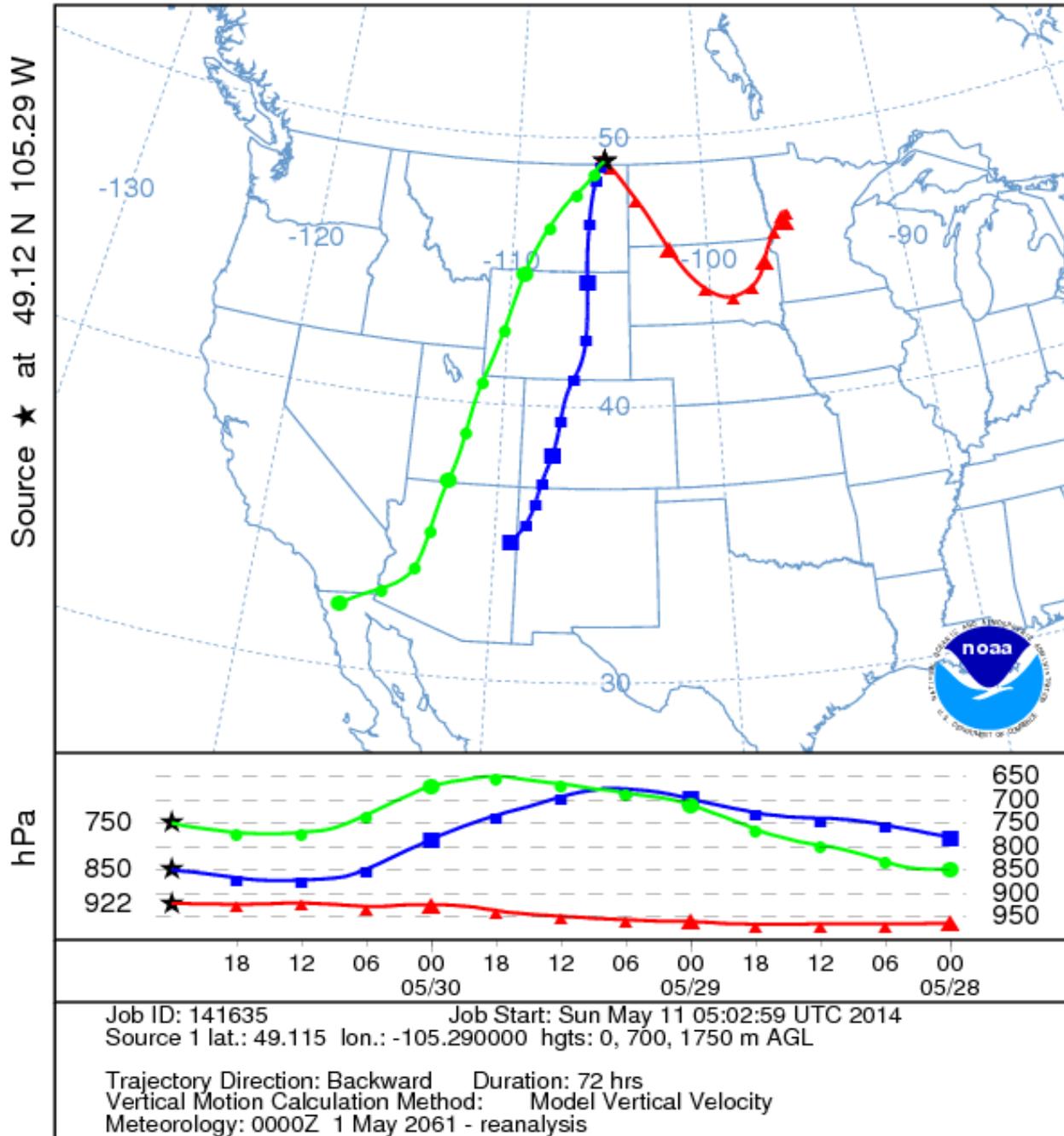
Precipitation (inches) Stations

0.9 - 1	6.01 - 7	◆ Daily
1.01 - 2	7.01 - 8	◇ Daily Estimated
2.01 - 3	8.01 - 9	■ Hourly
3.01 - 4	9.01 - 10	
4.01 - 5	10.01 - 11	
5.01 - 6		



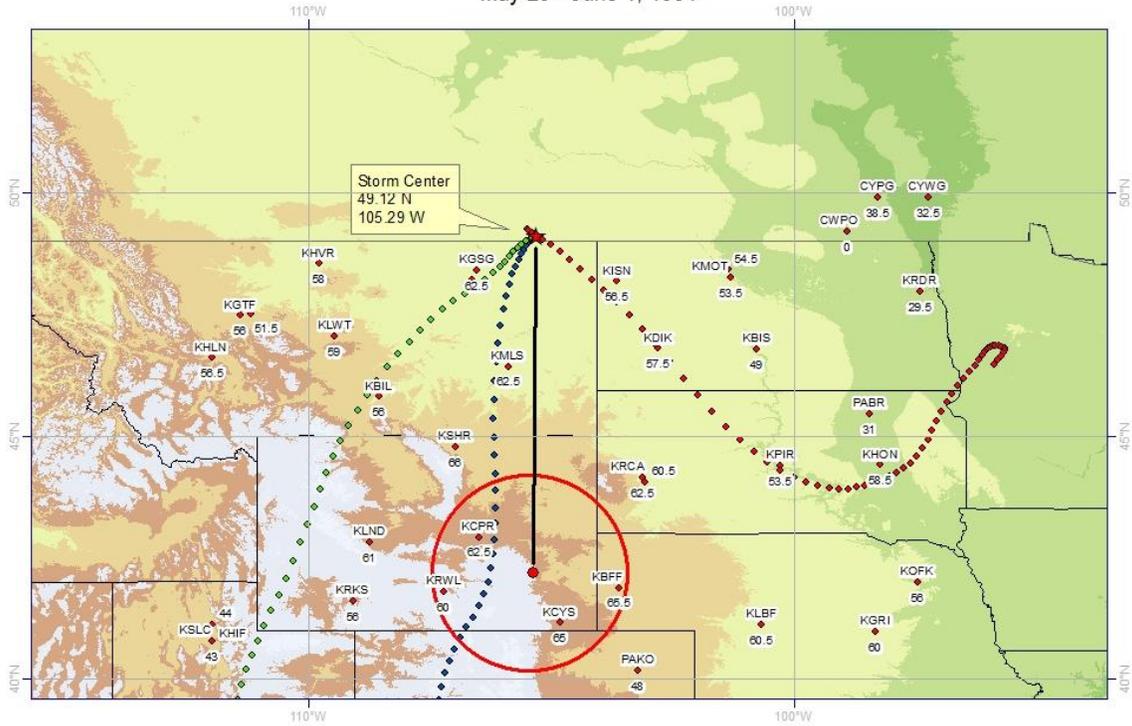
NOAA HYSPLIT MODEL

Backward trajectories ending at 0000 UTC 31 May 61 CDC1 Meteorological Data



SPAS 1334

May 29 - June 1, 1961



Hysplit

- ◆ Surface
- ◆ 850 mb
- ◆ 750 mb



Storm Precipitation Analysis System (SPAS) For Storm #1030_1 SPAS Analysis

General Storm Location: Wahoo, NE

Storm Dates: June 22-24, 1963

Event: Thunderstorm, possibly associated with a mesoscale convective complex (MCC)

DAD Zone 1

Latitude: 41.2132

Longitude: -97.0710

Rainfall Amount: 15.98 inches

Number of Stations: 222

SPAS Version: 2.0

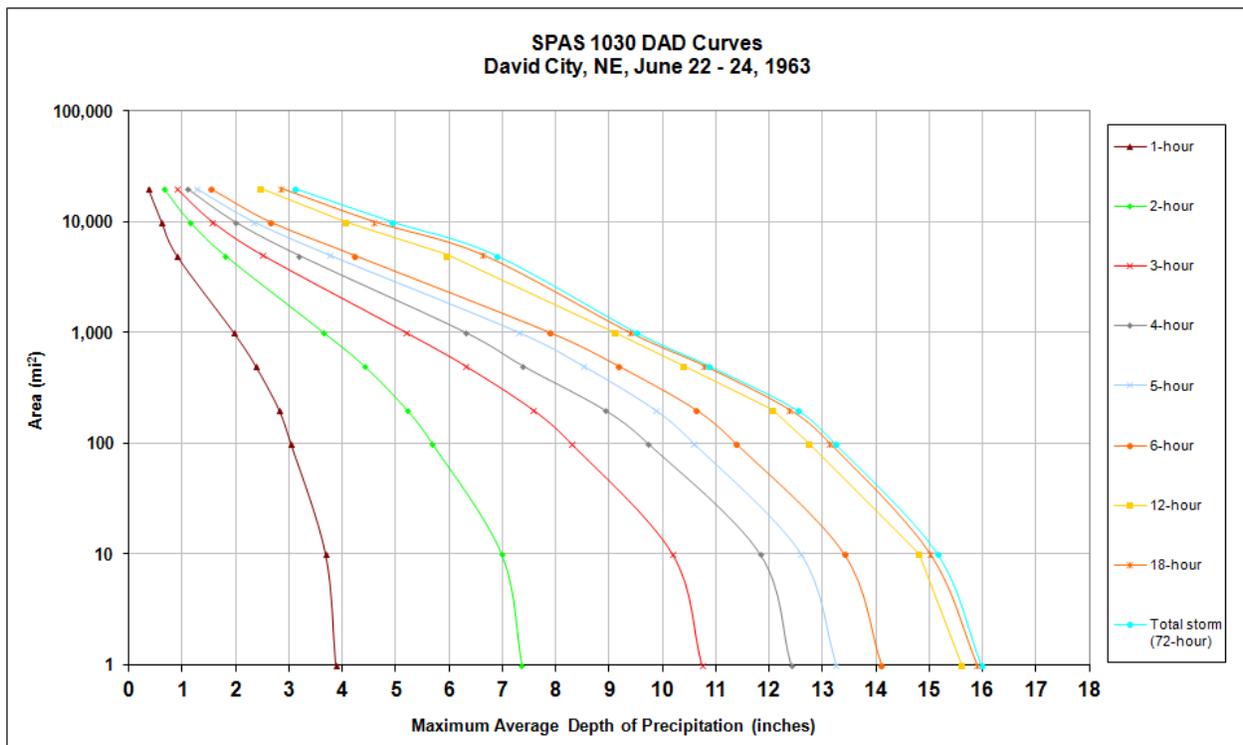
Base Map Used: No

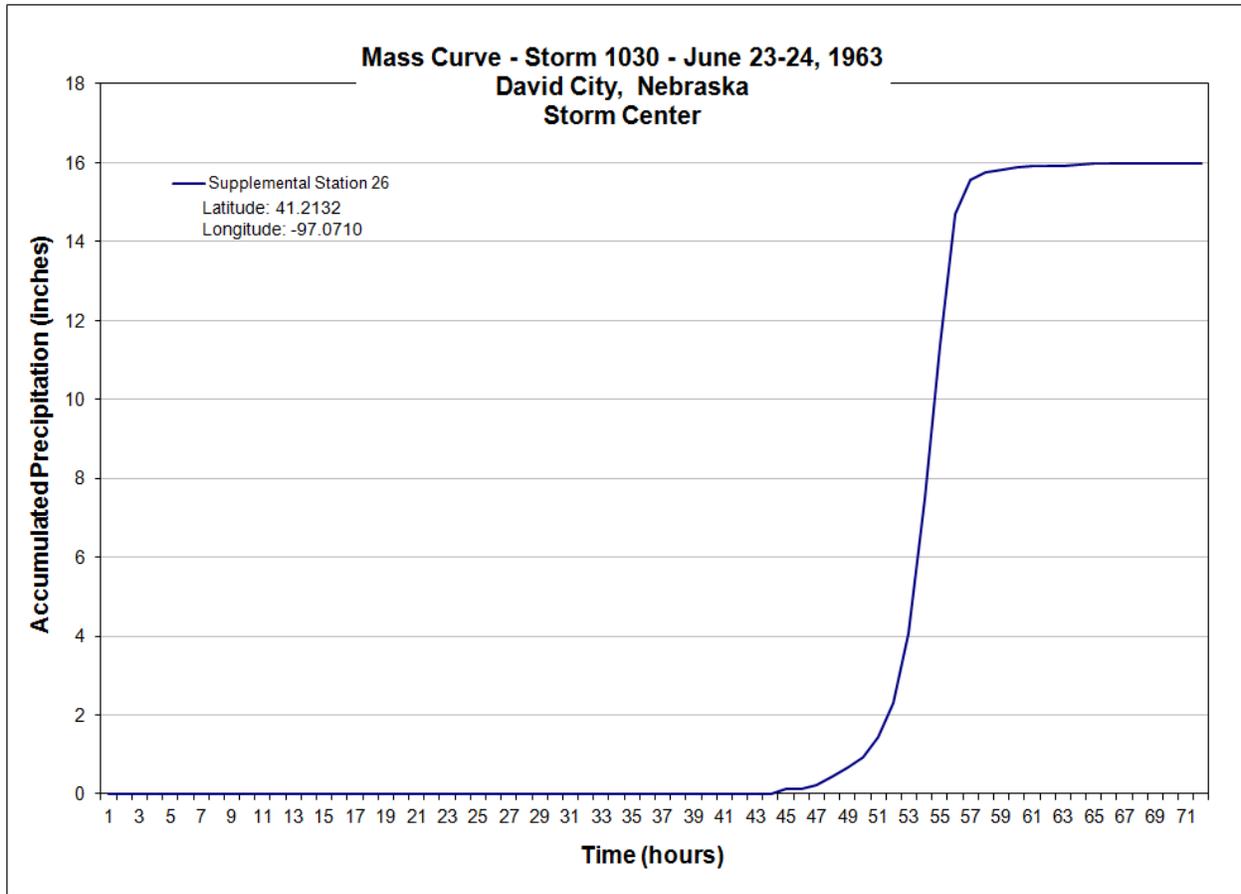
Radar Included: No

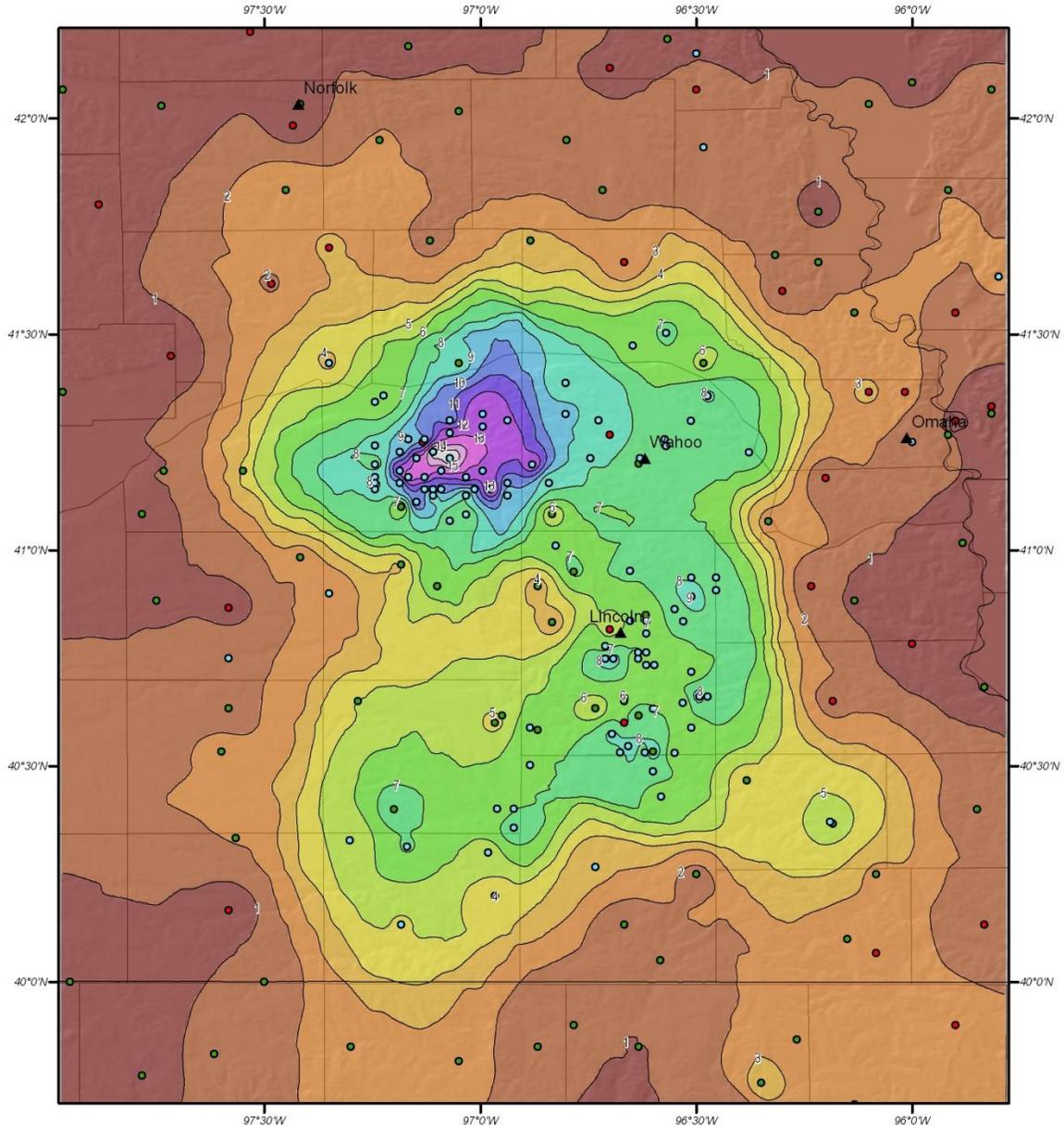
Depth-Area-Duration (DAD) analysis: Yes, 1, 2, 3, 4, 5, 6, 12, 18, 24, 36, 48, and 72 hours

SPAS Storm 1030 - David City, NE, June 22 - 24, 1963
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

Area (mi ²)	Duration (hours)												
	1	2	3	4	5	6	12	18	24	36	48	72	total
1	3.87	7.36	10.73	12.40	13.26	14.10	15.61	15.90	15.98	15.98	15.98	15.98	15.98
10	3.68	6.98	10.18	11.82	12.60	13.40	14.80	15.02	15.15	15.13	15.13	15.16	15.16
100	3.03	5.68	8.28	9.72	10.59	11.37	12.75	13.14	13.23	13.23	13.23	13.23	13.23
200	2.81	5.21	7.57	8.91	9.87	10.63	12.07	12.39	12.49	12.49	12.50	12.52	12.52
500	2.37	4.41	6.30	7.38	8.52	9.17	10.39	10.79	10.82	10.84	10.86	10.87	10.87
1,000	1.96	3.65	5.19	6.31	7.32	7.89	9.10	9.39	9.45	9.47	9.48	9.51	9.51
5,000	0.89	1.80	2.50	3.18	3.77	4.22	5.96	6.64	6.80	6.83	6.87	6.87	6.87
10,000	0.61	1.15	1.56	1.99	2.35	2.65	4.07	4.60	4.84	4.91	4.92	4.93	4.93
20,000	0.36	0.66	0.89	1.09	1.27	1.53	2.46	2.85	3.04	3.09	3.10	3.10	3.10

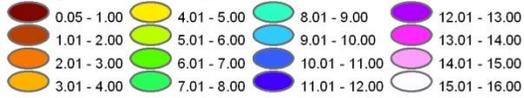




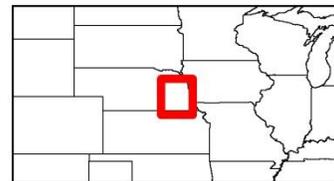


SPAS Storm #1030 - June 22 to 24, 1963
Total Rainfall (72-hours) - Wahoo, Nebraska

Precipitation (inches)

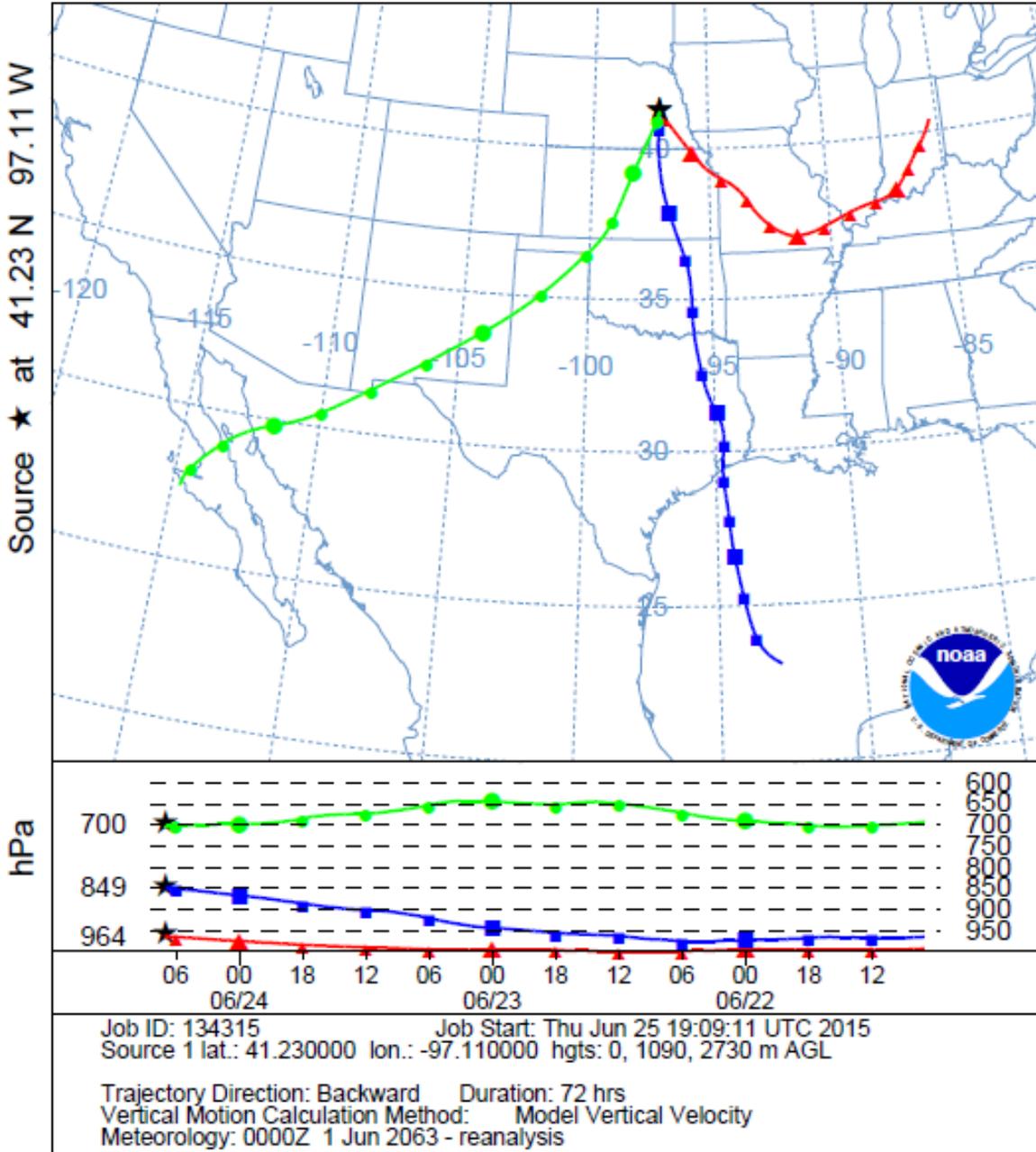


Gauging Stations

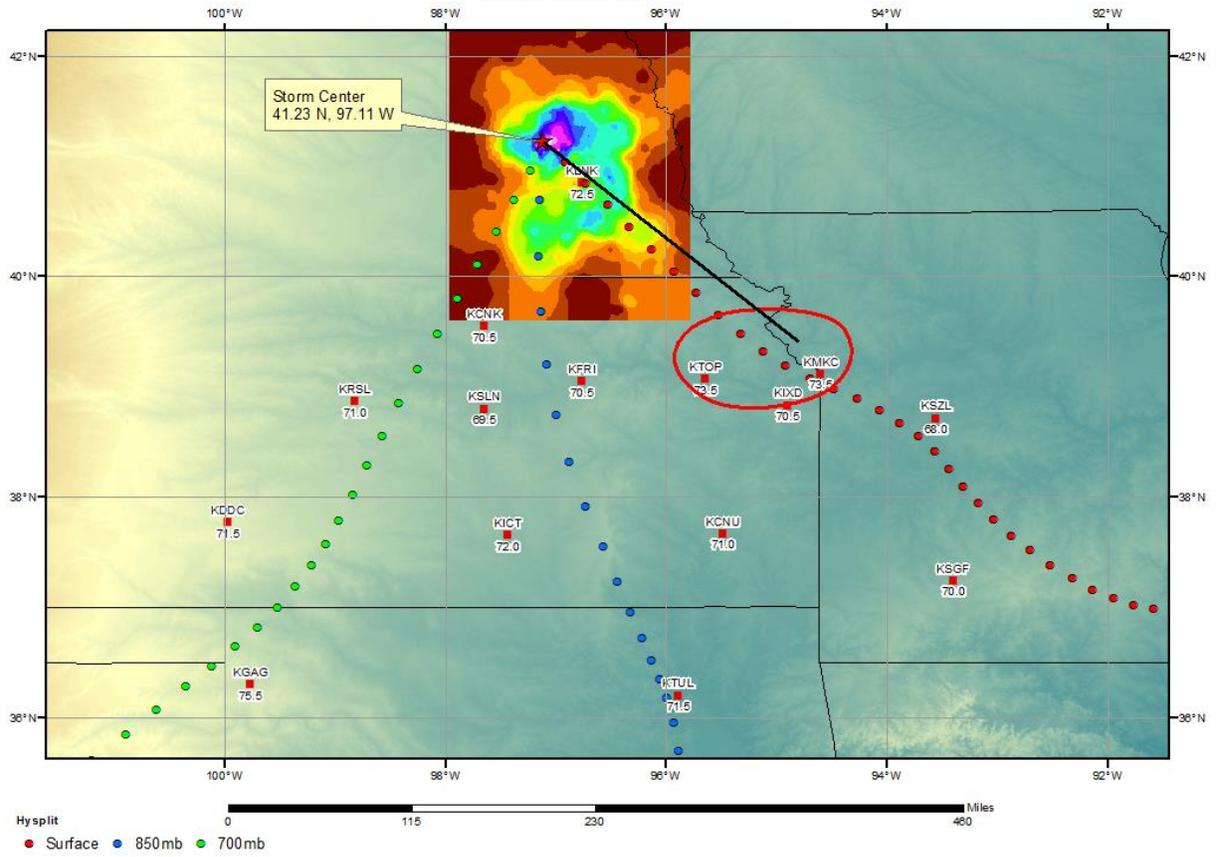


Coordinate system: GCS North American 1983
 Scale: 1:44,522,173 Metstat/AWA March 1, 2007

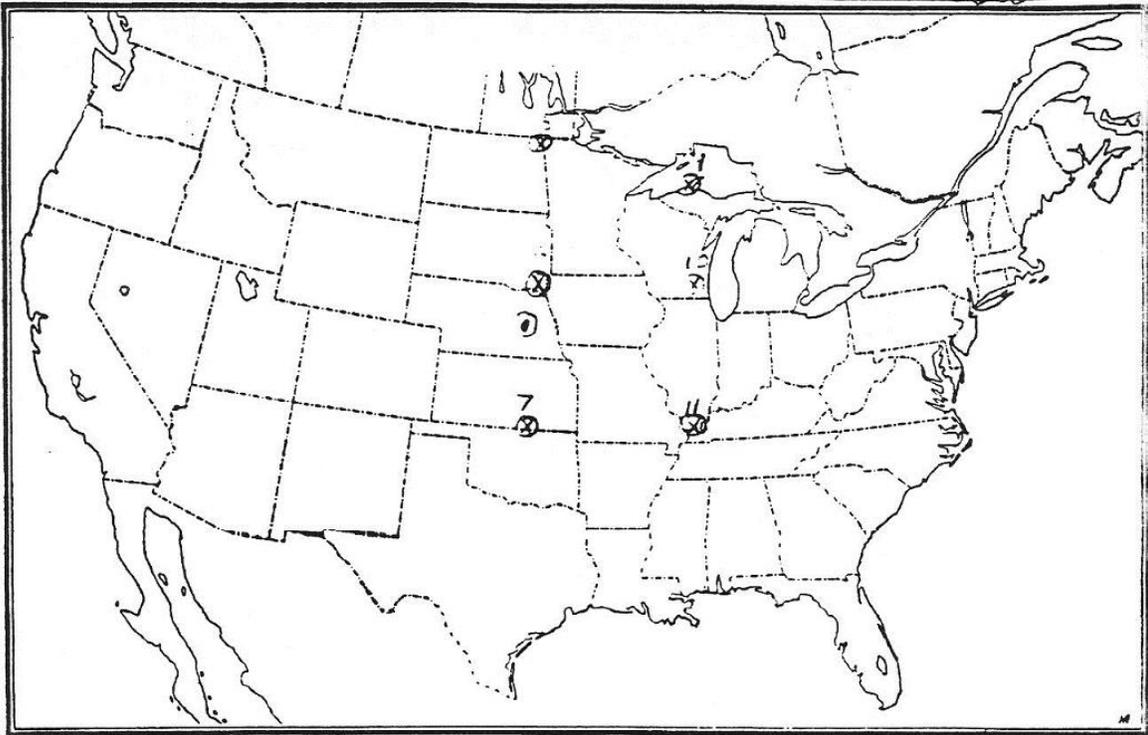
NOAA HYSPLIT MODEL
 Backward trajectories ending at 0700 UTC 24 Jun 63
 CDC1 Meteorological Data



SPAS 1030 David City, NE Storm Analysis June 21-24, 1963



June 23-24, 1963
David City, Nebr. 41°14' 9705'
FT.d = 71°F, 29058L



Storm Precipitation Analysis System (SPAS) For Storm #1324_1 SPAS Analysis

General Storm Location: Near Glen Ullin, ND (Stanton, ND)

Storm Dates: June 24, 1966

Event: Thunderstorm cloud-burst

DAD Zone 1

Latitude: 47.3041°

Longitude: -101.3875°

Max. grid rainfall amount: 327mm

Max. observed rainfall amount: 158mm (Glen Ullin, ND)

Number of Stations: 58

SPAS Version: 9.5

Base Map Used: Modified Digitized USGS Isohyetal Map

Spatial resolution: 30 seconds (degree: minute: second, WGS84, ~ 0.3 mi², 0.78 km²)

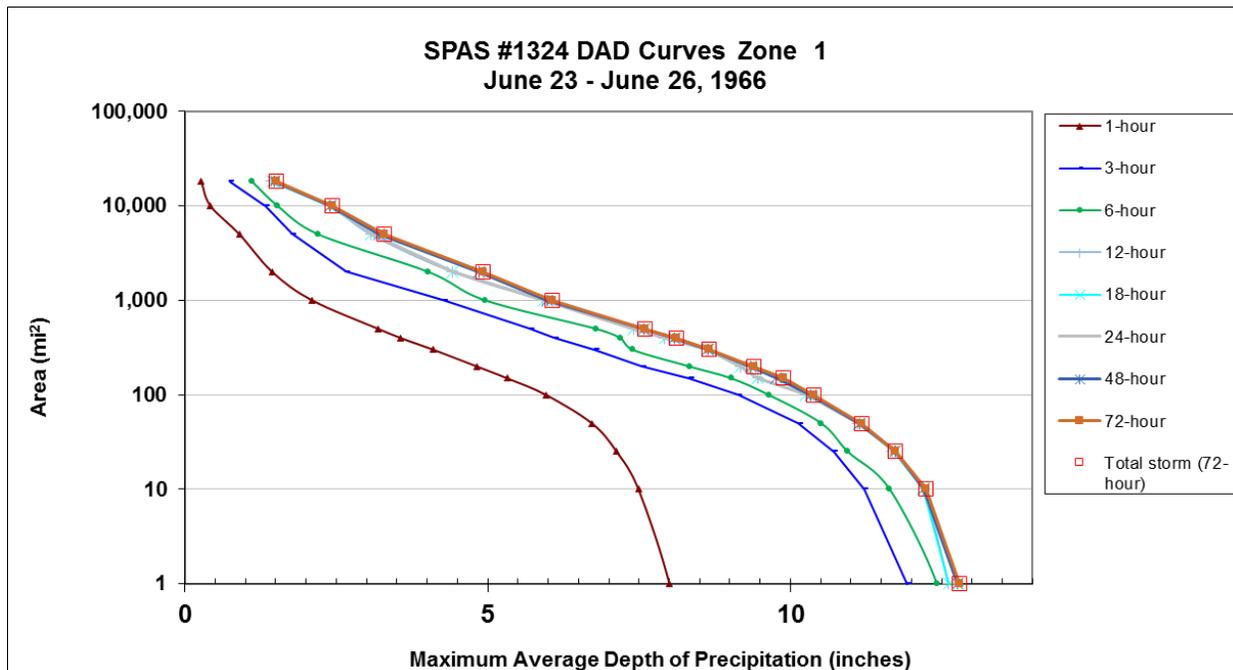
Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes

Reliability of Results: Given the analysis had 18 hourly stations, 39 daily stations and a detailed USGS total isohyetal map, the overall confidence in the results are higher than average. Three hourly stations resided at locations in/near the storm center, therefore increasing confidence amongst the heaviest precipitation. Heavy amounts of hail accompanied this storm, which may have influenced the timing at tipping bucket gauges. Unofficial, newspaper reports of up to "10 inches of rain in a half hour" could not be verified and therefore the analysis does not represent rainfall intensities that high. The maximum storm center precipitation is based on the fact the USGS report noted up to 13" of rain fell.

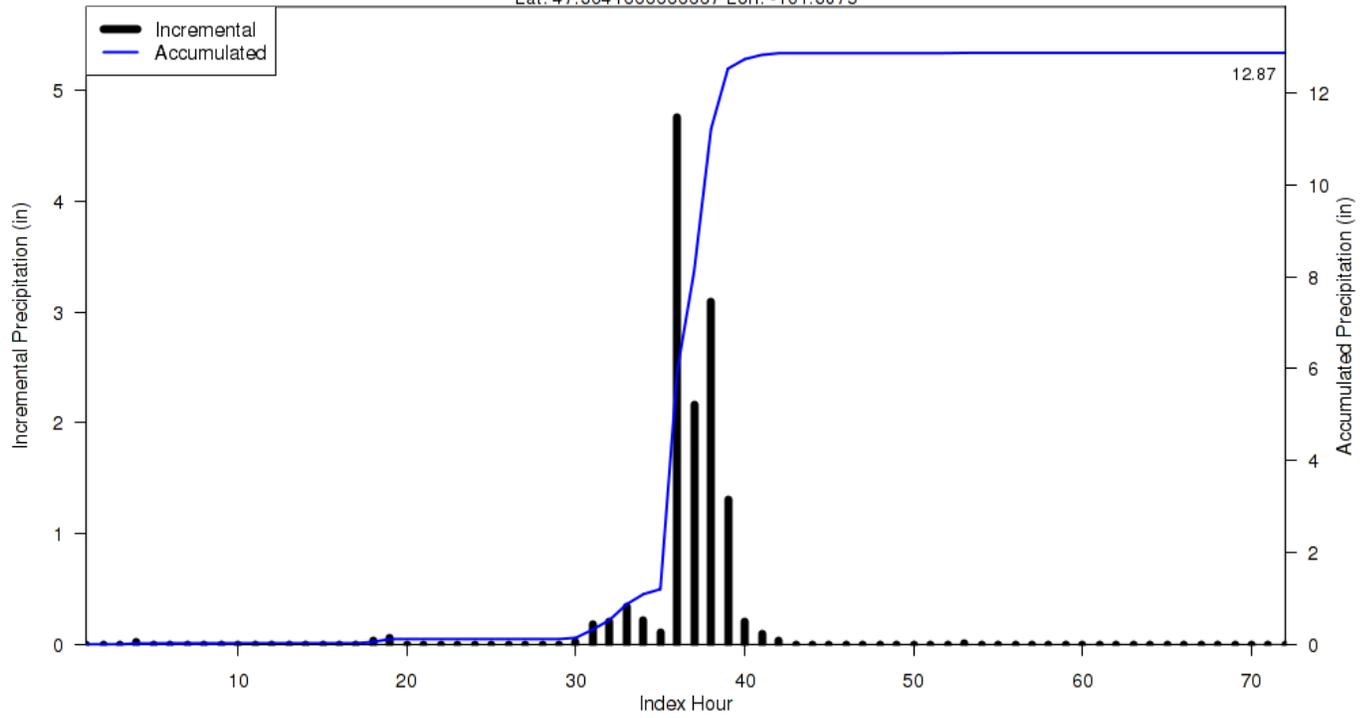
NOTE: This storm was included in NOAA Technical Report NWS 25 (Comparison of Generalized Estimates of Probable Maximum Precipitation With Greatest Observed Rainfalls, Washington, D.C., March 1980). This storm's observed rainfall was $\geq 50\%$ of the all-season PMP for 6-hr/10mi², 12-hr/10mi² and 6-hr/200mi².

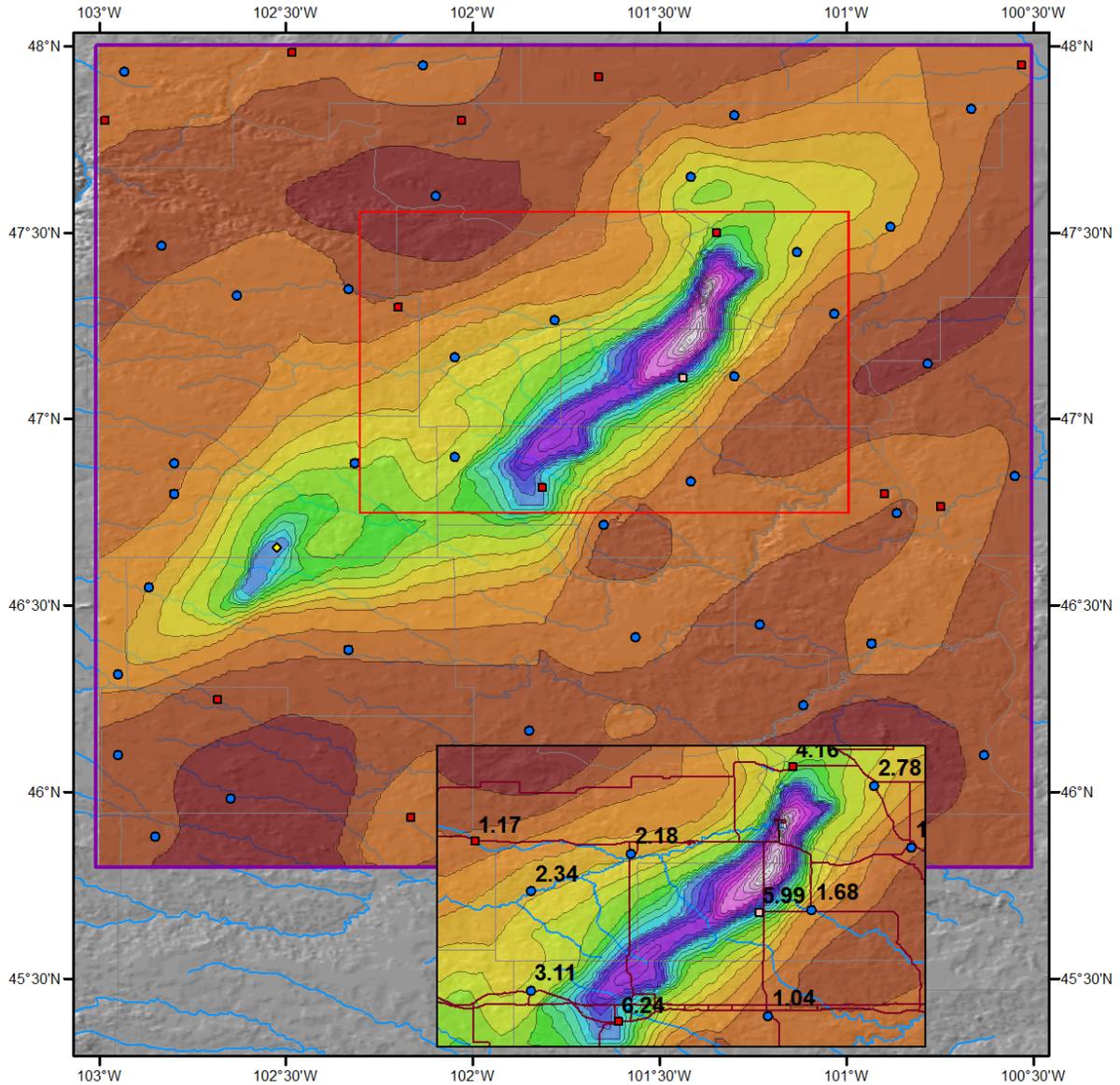
Storm 1324 - June 23 (0800 UTC) - June 26 (0700 UTC), 1966									
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)									
Area (mi ²)	Duration (hours)								
	1	3	6	12	18	24	48	72	Total
0.2	8.14	12.10	12.59	12.82	12.82	12.82	12.86	12.87	12.87
1	8.00	11.93	12.42	12.61	12.62	12.76	12.76	12.80	12.80
10	7.49	11.22	11.64	12.18	12.19	12.20	12.21	12.23	12.23
25	7.13	10.71	10.95	11.69	11.70	11.72	11.73	11.74	11.74
50	6.72	10.13	10.51	11.11	11.12	11.13	11.14	11.17	11.17
100	5.96	9.13	9.64	10.25	10.26	10.29	10.34	10.38	10.38
150	5.32	8.33	9.02	9.46	9.46	9.46	9.77	9.88	9.88
200	4.82	7.54	8.33	9.18	9.18	9.18	9.35	9.39	9.39
300	4.10	6.77	7.39	8.61	8.62	8.63	8.64	8.65	8.65
400	3.56	6.10	7.19	7.92	7.93	7.93	8.09	8.11	8.11
500	3.19	5.69	6.79	7.42	7.42	7.42	7.58	7.60	7.60
1,000	2.10	4.26	4.96	5.92	5.93	5.93	5.98	6.07	6.07
2,000	1.44	2.66	4.02	4.42	4.42	4.43	4.86	4.92	4.92
5,000	0.90	1.77	2.20	3.07	3.07	3.09	3.21	3.30	3.30
10,000	0.42	1.33	1.53	2.39	2.40	2.40	2.40	2.43	2.43
17,987	0.27	0.74	1.11	1.42	1.44	1.45	1.48	1.51	1.51



SPAS 1324 Storm Center Mass Curve Zone 1
June 23 (0800UTC) to June 26 (0700UTC), 1966

Lat: 47.3041666666667 Lon: -101.3875



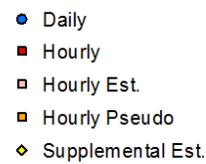


Total 72-hr Precipitation (inches)
June 23, 1966 0700 UTC - June 25, 1966 0700 UTC
SPAS #1324

Precipitation (inches)



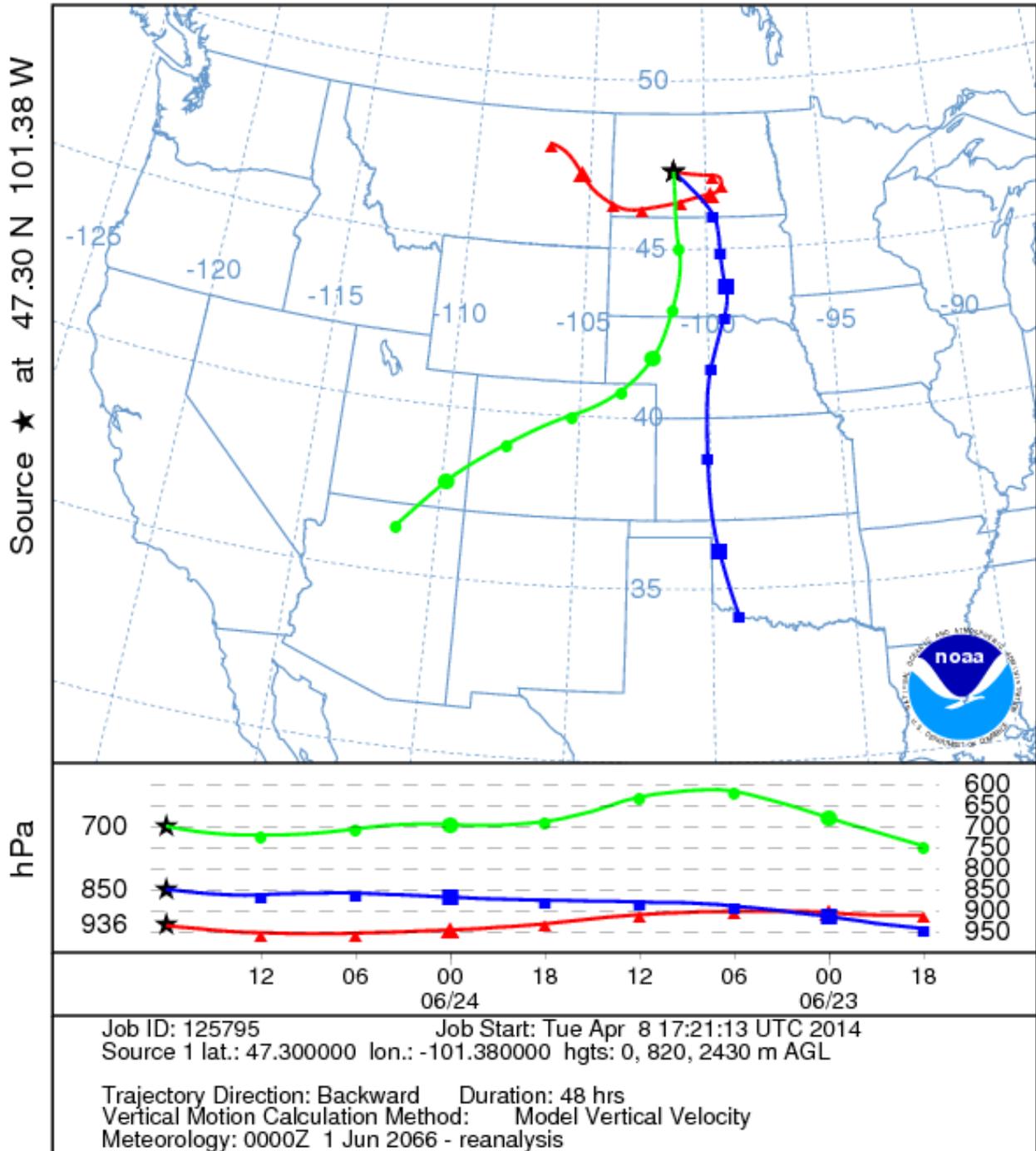
Stations



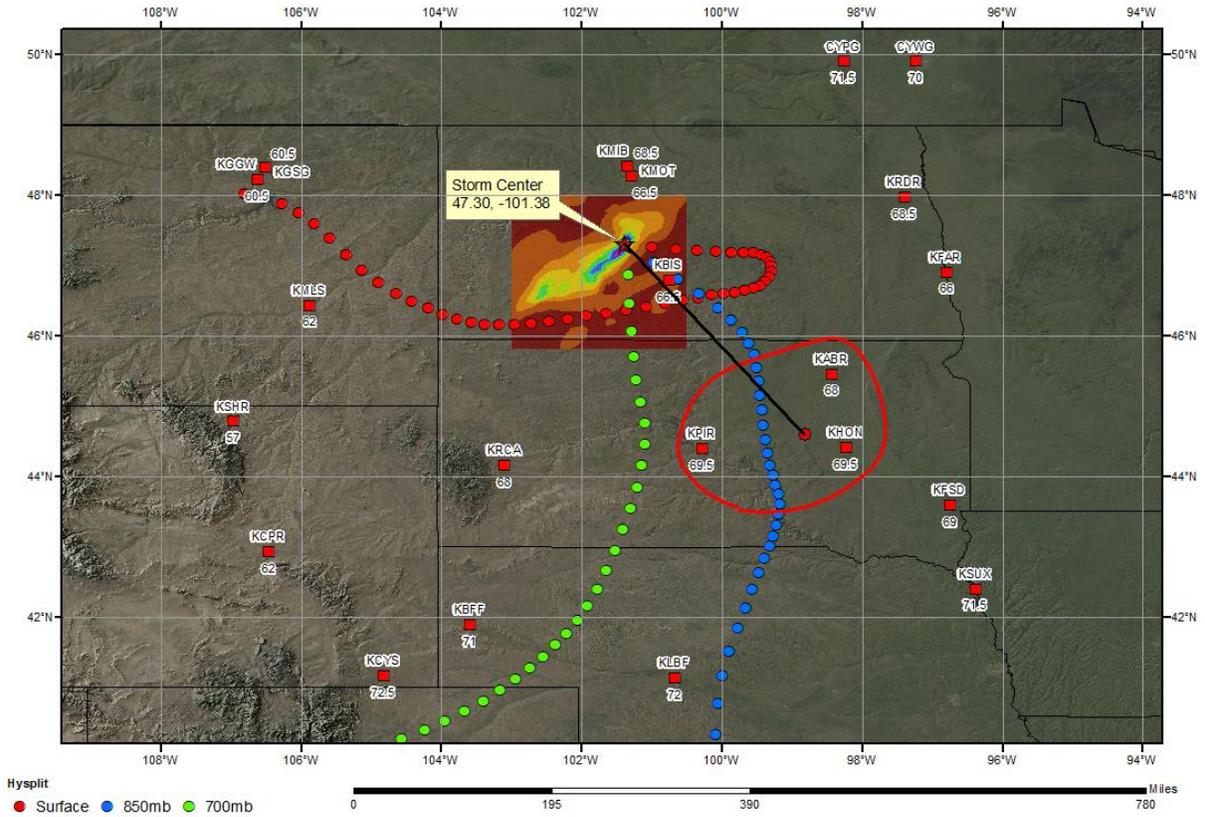
NOAA HYSPLIT MODEL

Backward trajectories ending at 1800 UTC 24 Jun 66

CDC1 Meteorological Data



SPAS 1324 Glen Ullin, ND Storm Analysis June 23-24, 1966



Storm Precipitation Analysis System (SPAS) For Storm #1209_1 SPAS Analysis

General Storm Location: Wooster, Ohio – the "Independence Day storm"

Storm Dates: July 4-6, 1969 (July 4, 1969 0600 UTC – July 7, 1969 0500 UTC: 72 hours)

Event: Thunderstorm

DAD Zone 1

Latitude: 40.91458

Longitude: 81.9729

Max. Grid Rainfall Amount: 14.95"***

Max. Observed Rainfall Amount: 14.82" at Wooster 8 NNW***

Number of Stations: 509 (77 Daily, 46 Hourly, 2 Hourly Estimated, 3 Hourly Estimated Pseudo, 14 Hourly Pseudo, 360 Supplemental, and 7 Supplemental Estimated)

SPAS Version: 8.5

Base Map Used: Blended USGS, USACE, NWS and SPAS total storm isohyetal converted into a grid.

Spatial resolution: 15 seconds* (~ 0.25 mi²)

Radar Included: No

Depth-Area-Duration (DAD) analysis: Yes**

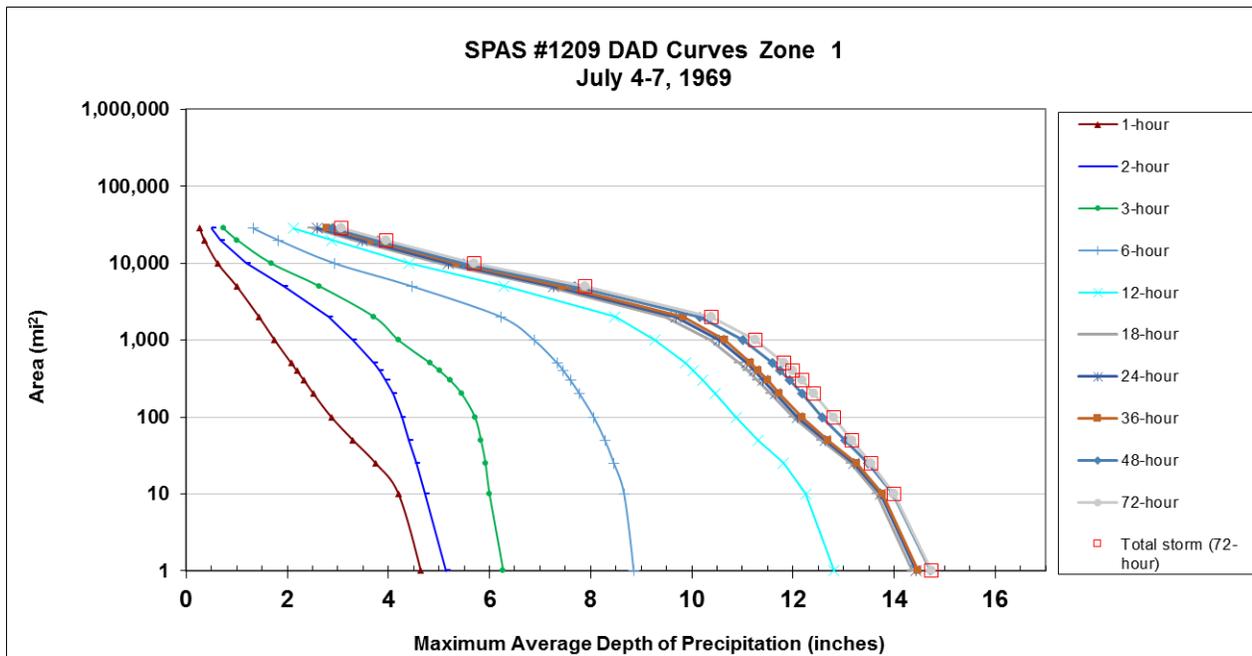
Reliability of results: Although this storm analysis obviously did not use radar data, the abundant gauge data and well positioned hourly rain gauges provided excellent spatial and temporal information and therefore a very high degree of confidence in the final results.

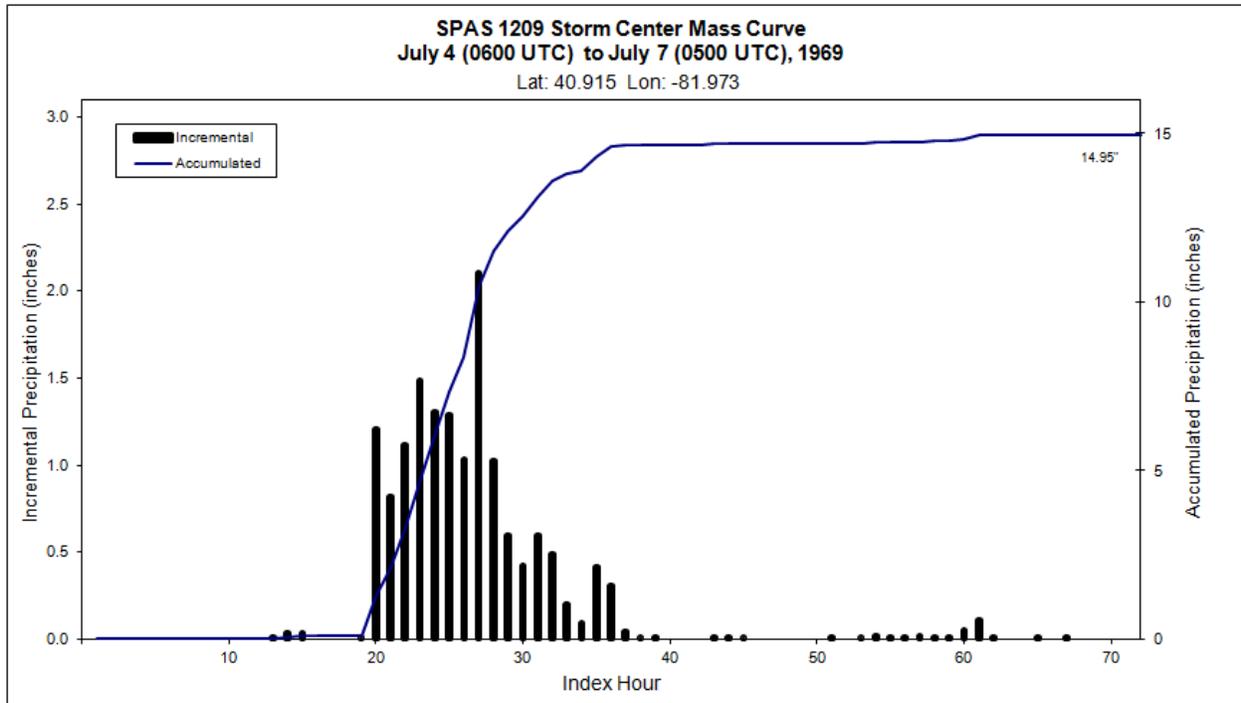
*A higher spatial resolution (15-sec vs. 30-sec) was used in this analysis to better capture the spatial details.

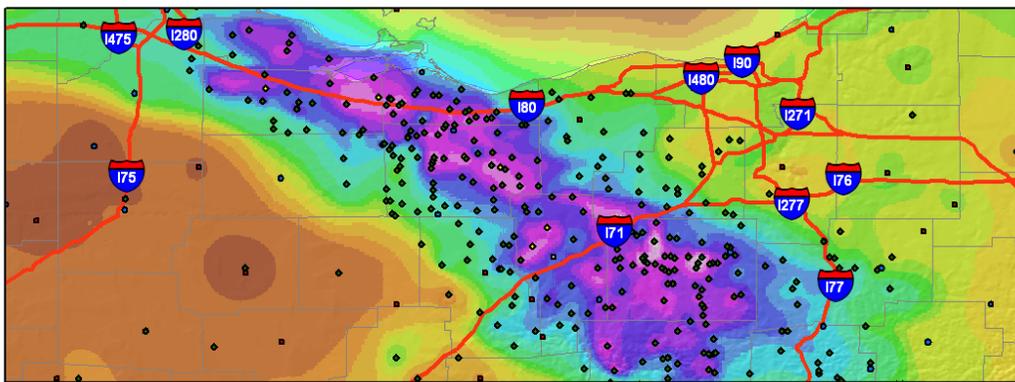
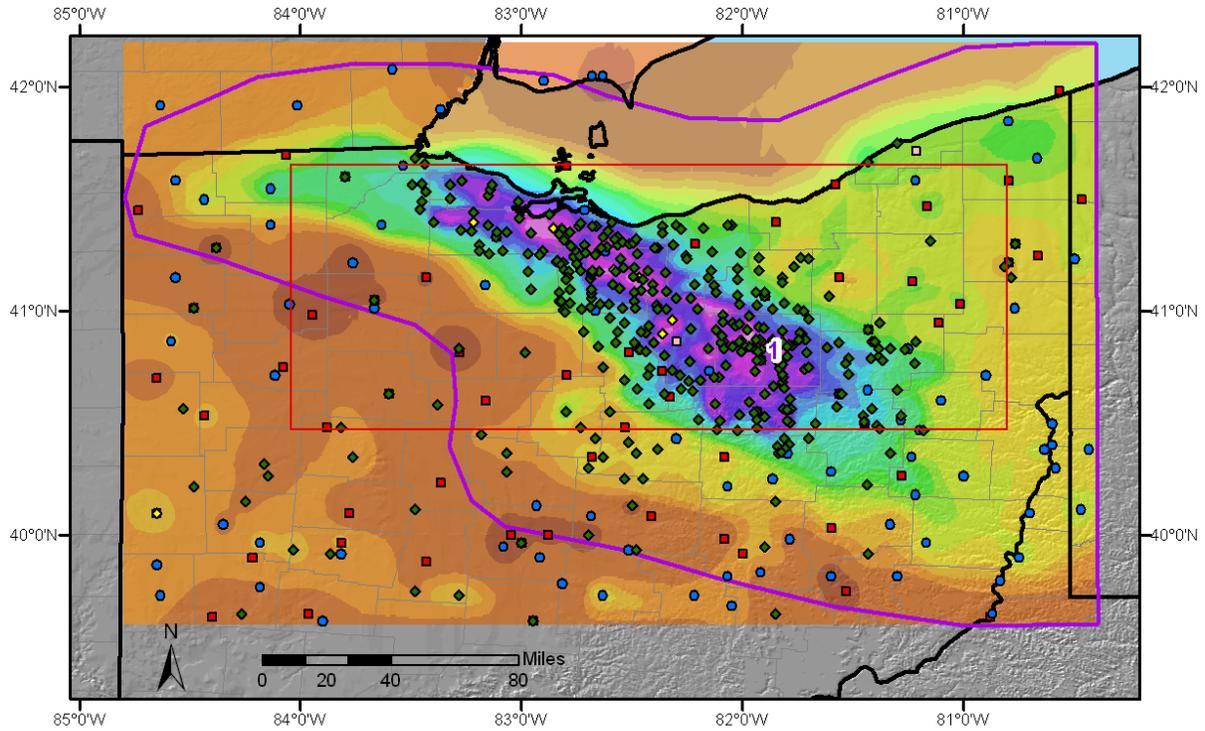
** The southwestern portion of the domain was NOT included in the DAD zone since a separate squall line passed through this area on July 6th, which is temporally very separate than the main event during the night of July 4th.

*** An unreliable and unofficial amount of 18" was reported (see below) near Wooster, but we choose not to use this amount because we couldn't corroborate it with other sources. As it is, our storm center exceeds the highest official rainfall amount by 0.13".

Storm 1209 - July 4 (0600 UTC) - July 7 (0500 UTC), 1969											
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)											
Area (mi ²)	Duration (hours)										
	1	2	3	6	12	18	24	36	48	72	Total
0.4	4.73	5.23	6.34	8.88	12.89	14.44	14.52	14.55	14.79	14.81	14.81
1	4.64	5.14	6.27	8.85	12.81	14.36	14.44	14.47	14.71	14.73	14.73
10	4.20	4.73	6.00	8.66	12.26	13.66	13.73	13.77	13.98	14.00	14.00
25	3.75	4.55	5.92	8.46	11.81	13.15	13.21	13.26	13.49	13.55	13.55
50	3.30	4.41	5.83	8.28	11.31	12.57	12.64	12.69	13.03	13.17	13.17
100	2.87	4.26	5.71	8.06	10.87	12.02	12.09	12.18	12.59	12.81	12.81
200	2.52	4.09	5.45	7.78	10.47	11.56	11.65	11.74	12.18	12.42	12.42
300	2.33	3.95	5.22	7.60	10.22	11.30	11.41	11.50	11.93	12.18	12.18
400	2.19	3.83	5.01	7.46	10.03	11.10	11.23	11.32	11.75	11.99	11.99
500	2.08	3.72	4.83	7.34	9.88	10.94	11.08	11.17	11.60	11.83	11.83
1,000	1.75	3.30	4.20	6.88	9.28	10.37	10.53	10.65	11.02	11.25	11.25
2,000	1.44	2.82	3.72	6.23	8.48	9.48	9.69	9.83	10.17	10.38	10.38
5,000	1.00	1.93	2.64	4.47	6.29	7.13	7.26	7.44	7.69	7.89	7.89
10,000	0.62	1.19	1.68	2.93	4.41	5.03	5.18	5.36	5.49	5.69	5.69
20,000	0.36	0.68	1.01	1.82	2.88	3.36	3.49	3.67	3.78	3.95	3.95
28,280	0.27	0.51	0.74	1.33	2.13	2.50	2.59	2.79	2.89	3.06	3.06





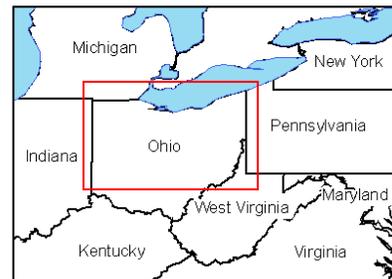


Wooster, Ohio "Independence Day storm" - ISOHYETAL FROM SPAS

Total 72-hour Rainfall (inches)
07/04/1969 0600 UTC - 07/07/1969 0500 UTC
SPAS #1209

Inches

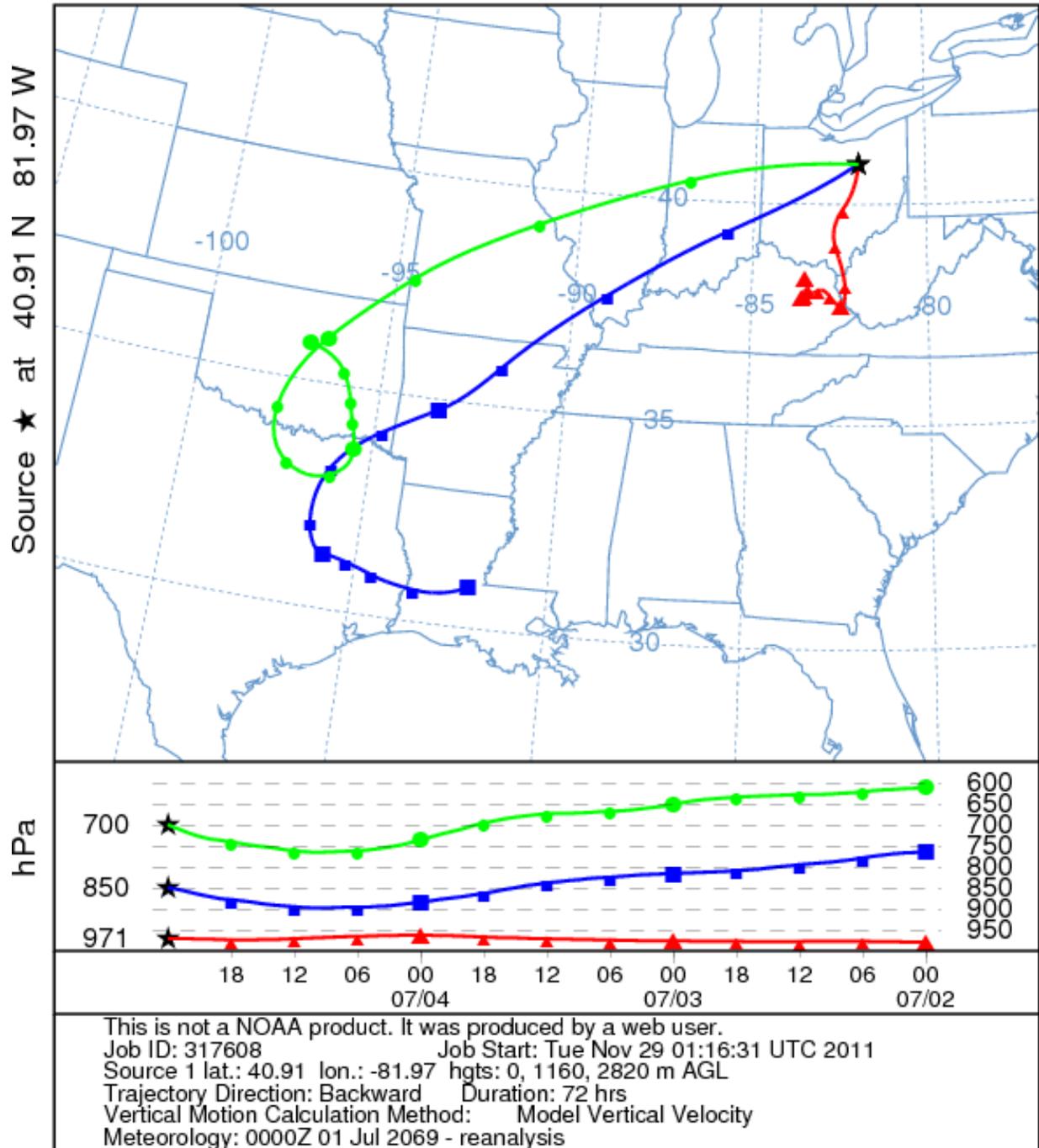
- | | | | |
|-------------|-------------|---------------|----------------------|
| 0.00 | 3.01 - 3.50 | 9.01 - 10.00 | • Daily |
| 0.01 - 0.50 | 3.51 - 4.00 | 10.01 - 11.00 | ■ Hourly |
| 0.51 - 1.00 | 4.01 - 5.00 | 11.01 - 12.00 | □ Hourly Est. |
| 1.01 - 1.50 | 5.01 - 6.00 | 12.01 - 13.00 | ■ Hourly Est. Pseudo |
| 1.51 - 2.00 | 6.01 - 7.00 | 13.01 - 14.00 | ■ Hourly Pseudo |
| 2.01 - 2.50 | 7.01 - 8.00 | >14.00 | ◆ Supplemental |
| 2.51 - 3.00 | 8.01 - 9.00 | DAD zone | ◆ Supplemental Est. |



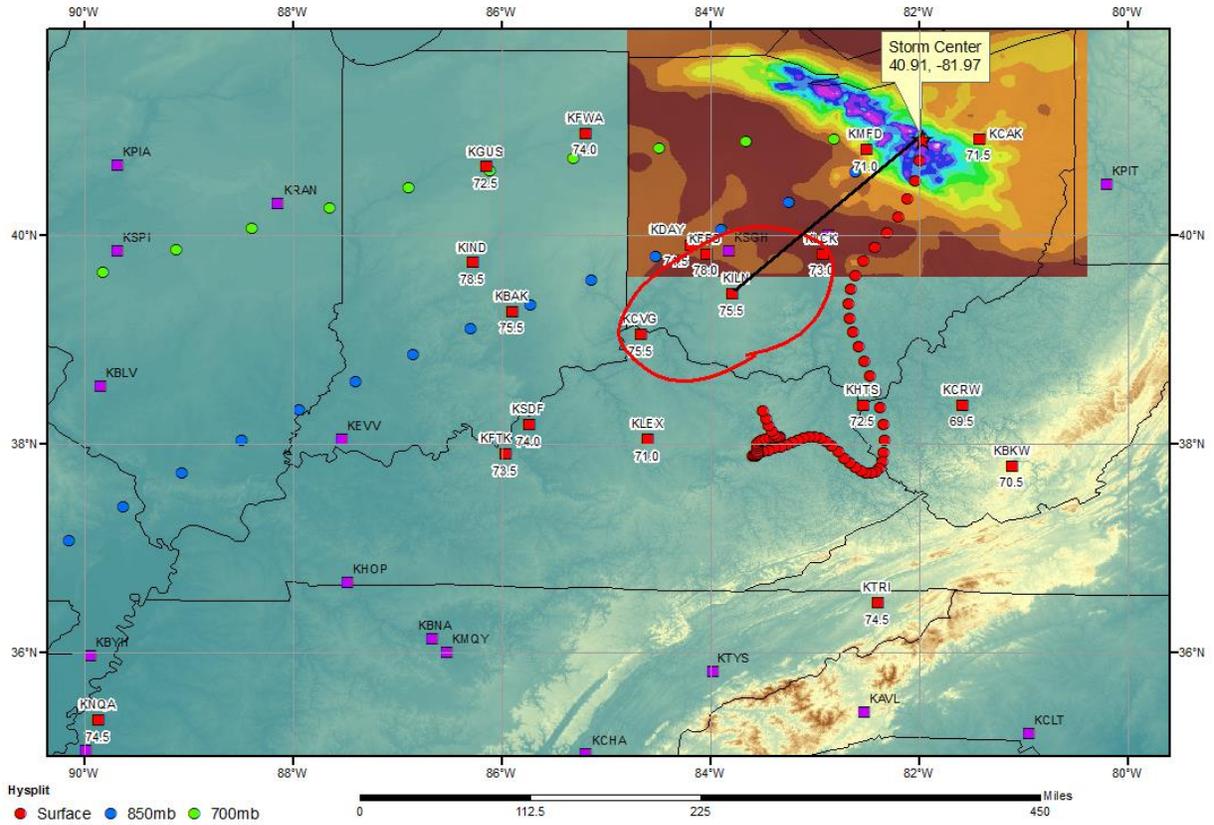
NOAA HYSPLIT MODEL

Backward trajectories ending at 0000 UTC 05 Jul 69

CDC1 Meteorological Data



SPAS 1209 Wooster, OH Storm Analysis July 2-5, 1969



Storm Precipitation Analysis System (SPAS) For Storm #1744_1 SPAS Analysis

General Storm Location: East Trout Lake, Saskatchewan

Storm Dates: July 10-11, 1974

Event: Synoptic

DAD Zone 1

Latitude: 54.4375

Longitude: -104.7542

Max. Grid Rainfall Amount: 12.32"

Max. Observed Rainfall Amount: 12.00:

Number of Stations: 39

SPAS Version: 10.0

Basemap: Isohyetal from HYD-8-12 Environment Saskatchewan

Spatial resolution: 0.20

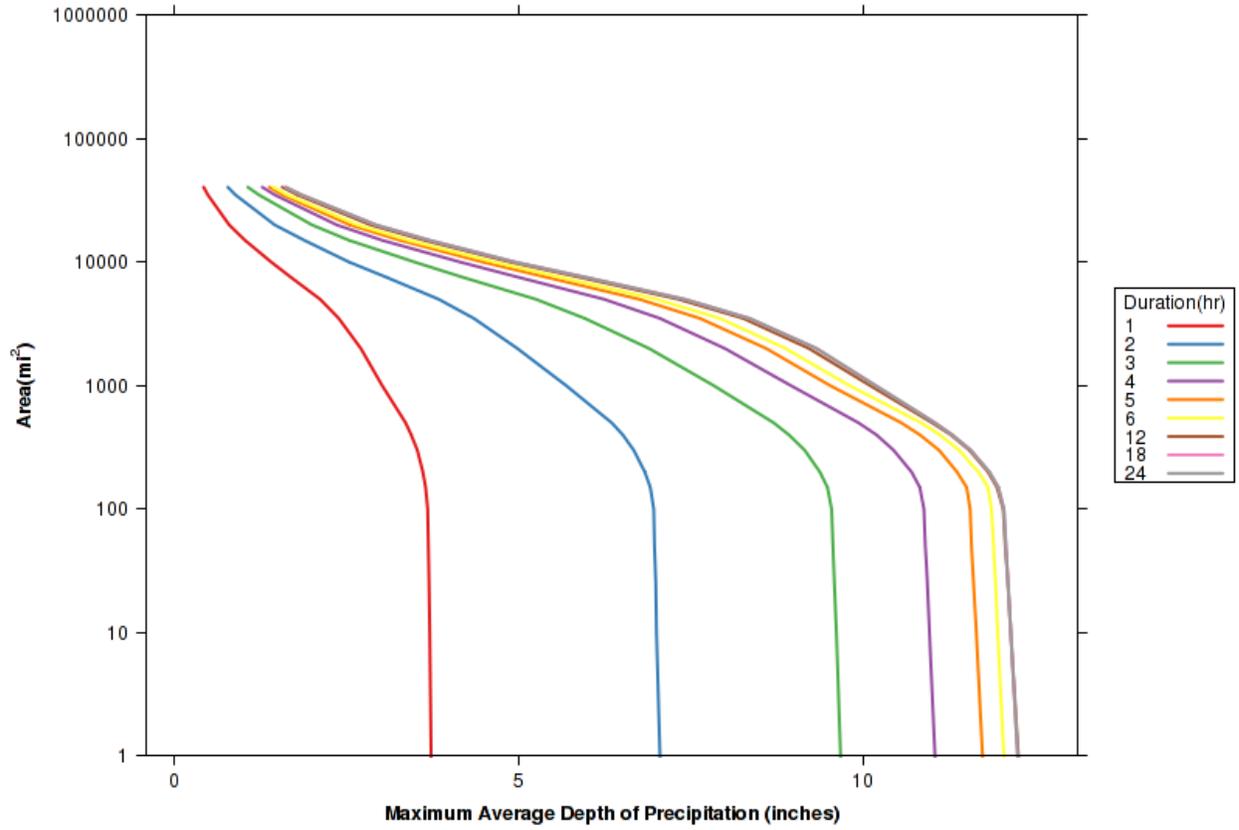
Radar Included: No

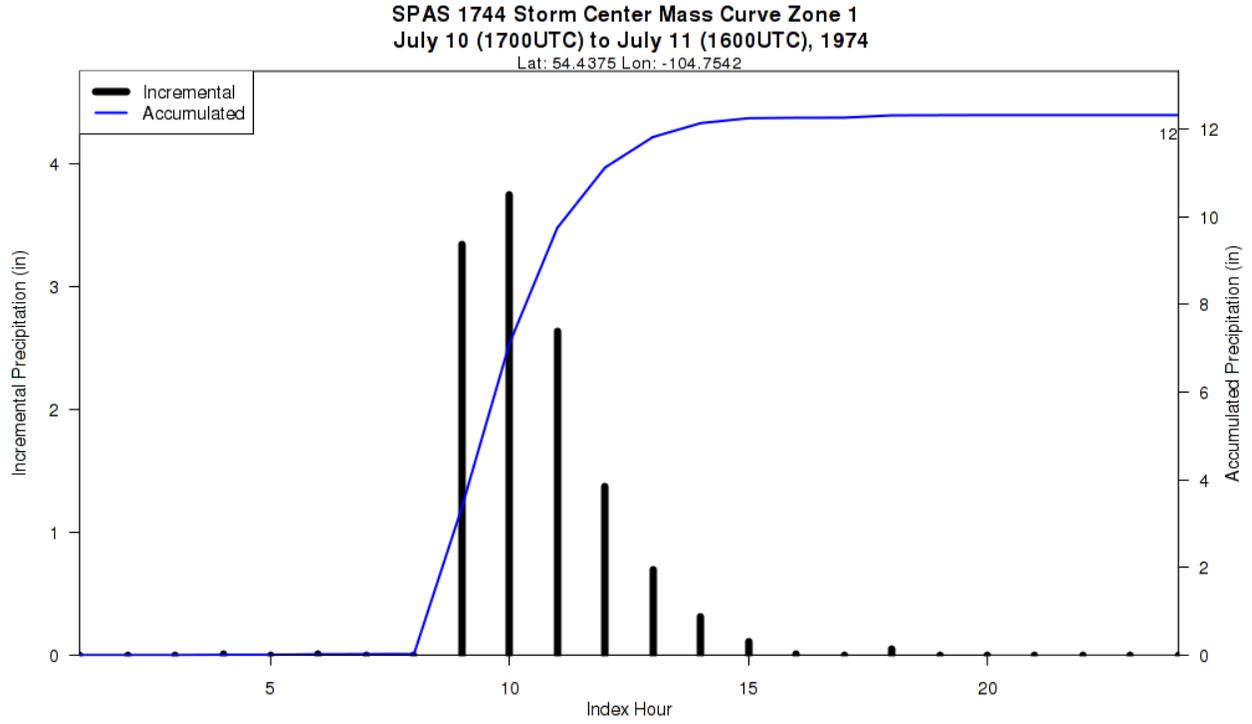
Depth-Area-Duration (DAD) analysis: Yes

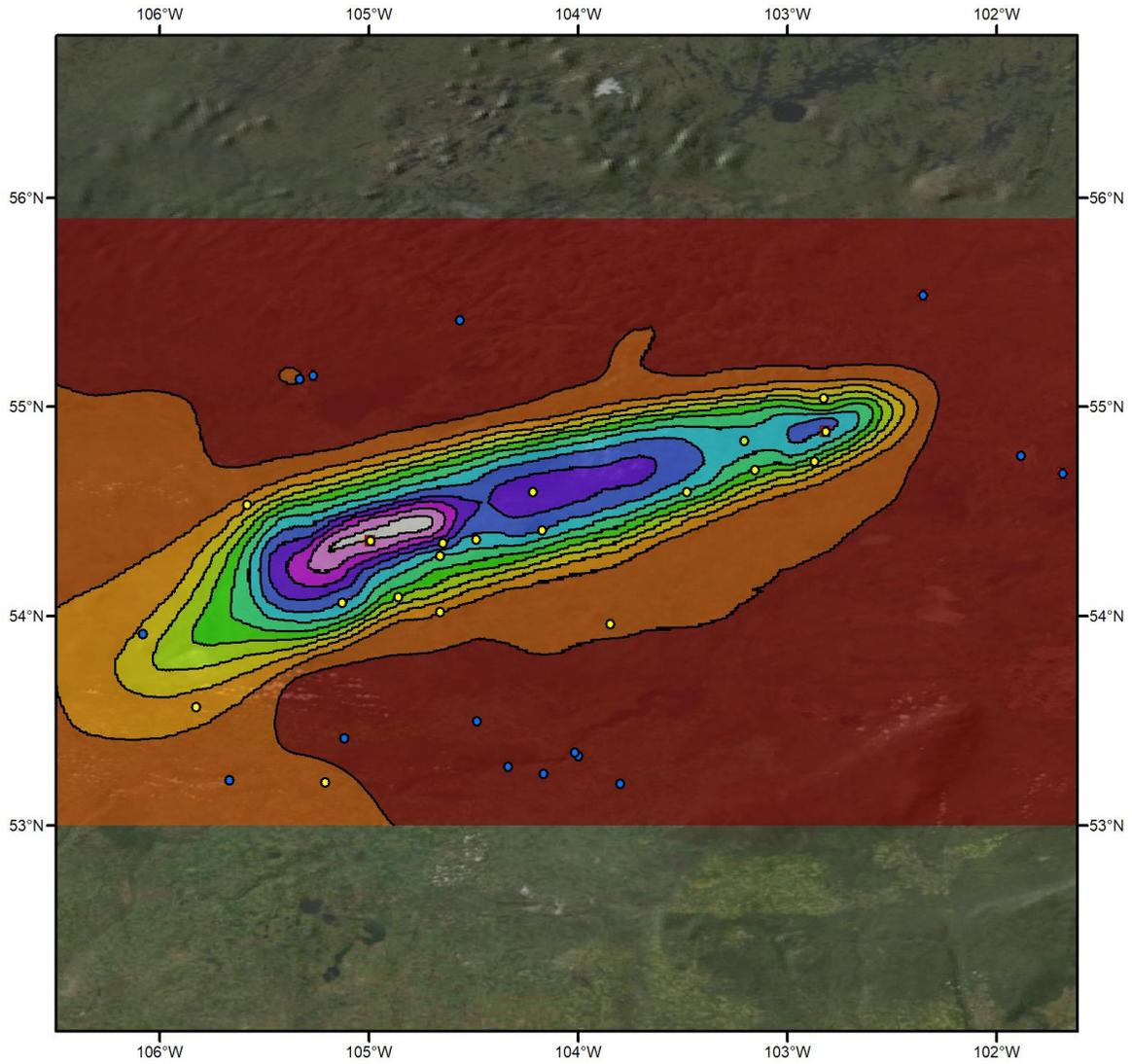
Reliability of results: This analysis was based on 39 hourly stations, daily data, supplemental station data and radar data. We have a good degree of confidence in the spatial pattern and limited confidence in the temporal pattern. The spatial pattern is fully dependent basemap and gauge stations. Timing is based on two hourly stations derived based on NOAA Atlas 14 Temporal patterns (Midwest region) and bucket survey timing reports. Most daily stations were moved to supplemental due to timing issues (On observation time) and to ensure data consistency.

SPAS 1744 - July 10 (1700 UTC) - July 11 (1600 UTC), 1974										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi²)	Duration (hours)									
	1hr	2hr	3hr	4hr	5hr	6hr	12hr	18hr	24hr	Total
0.4	3.74	7.07	9.70	11.07	11.76	12.08	12.29	12.28	12.28	12.28
1	3.73	7.05	9.67	11.04	11.73	12.04	12.25	12.24	12.24	12.24
10	3.71	7.00	9.61	10.96	11.64	11.95	12.14	12.14	12.14	12.14
25	3.70	6.99	9.58	10.93	11.60	11.92	12.10	12.10	12.10	12.10
50	3.69	6.97	9.56	10.90	11.57	11.89	12.06	12.07	12.07	12.07
100	3.68	6.96	9.54	10.88	11.55	11.86	12.03	12.04	12.04	12.04
150	3.65	6.91	9.48	10.82	11.50	11.81	11.94	11.96	11.96	11.96
200	3.61	6.83	9.37	10.70	11.36	11.67	11.81	11.83	11.83	11.83
300	3.53	6.67	9.15	10.44	11.10	11.39	11.54	11.56	11.56	11.56
400	3.44	6.51	8.92	10.19	10.82	11.11	11.27	11.29	11.29	11.29
500	3.36	6.35	8.70	9.93	10.55	10.84	11.00	11.04	11.04	11.04
1,000	3.02	5.69	7.83	8.95	9.52	9.80	10.10	10.18	10.18	10.18
2,000	2.71	4.98	6.89	7.99	8.59	8.87	9.21	9.32	9.32	9.32
3,500	2.39	4.35	5.96	7.05	7.63	7.92	8.26	8.35	8.35	8.35
5,000	2.12	3.84	5.25	6.24	6.75	7.00	7.32	7.41	7.41	7.41
7,500	1.70	3.09	4.20	5.01	5.42	5.62	5.90	5.99	5.99	5.99
10,000	1.41	2.54	3.49	4.15	4.48	4.65	4.88	4.95	4.95	4.95
15,000	1.03	1.89	2.54	3.02	3.28	3.40	3.63	3.71	3.71	3.71
20,000	0.80	1.46	2.00	2.36	2.55	2.66	2.85	2.93	2.93	2.93
35,000	0.49	0.89	1.23	1.46	1.57	1.64	1.79	1.85	1.85	1.85
40,419	0.43	0.78	1.07	1.28	1.38	1.44	1.57	1.62	1.62	1.62

SPAS 1744 DAD Curves Zone 1 July 10 (1700UTC) to July 11 (1600UTC), 1974



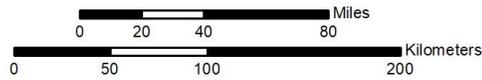




**Total Storm (24-hr) Precipitation (inches)
7/10/1974 1700 UTC - 7/11/1974 1600 UTC
SPAS #1744**

Gauges

- Daily
- Hourly
- Supplemental
- Supplemental Estimated



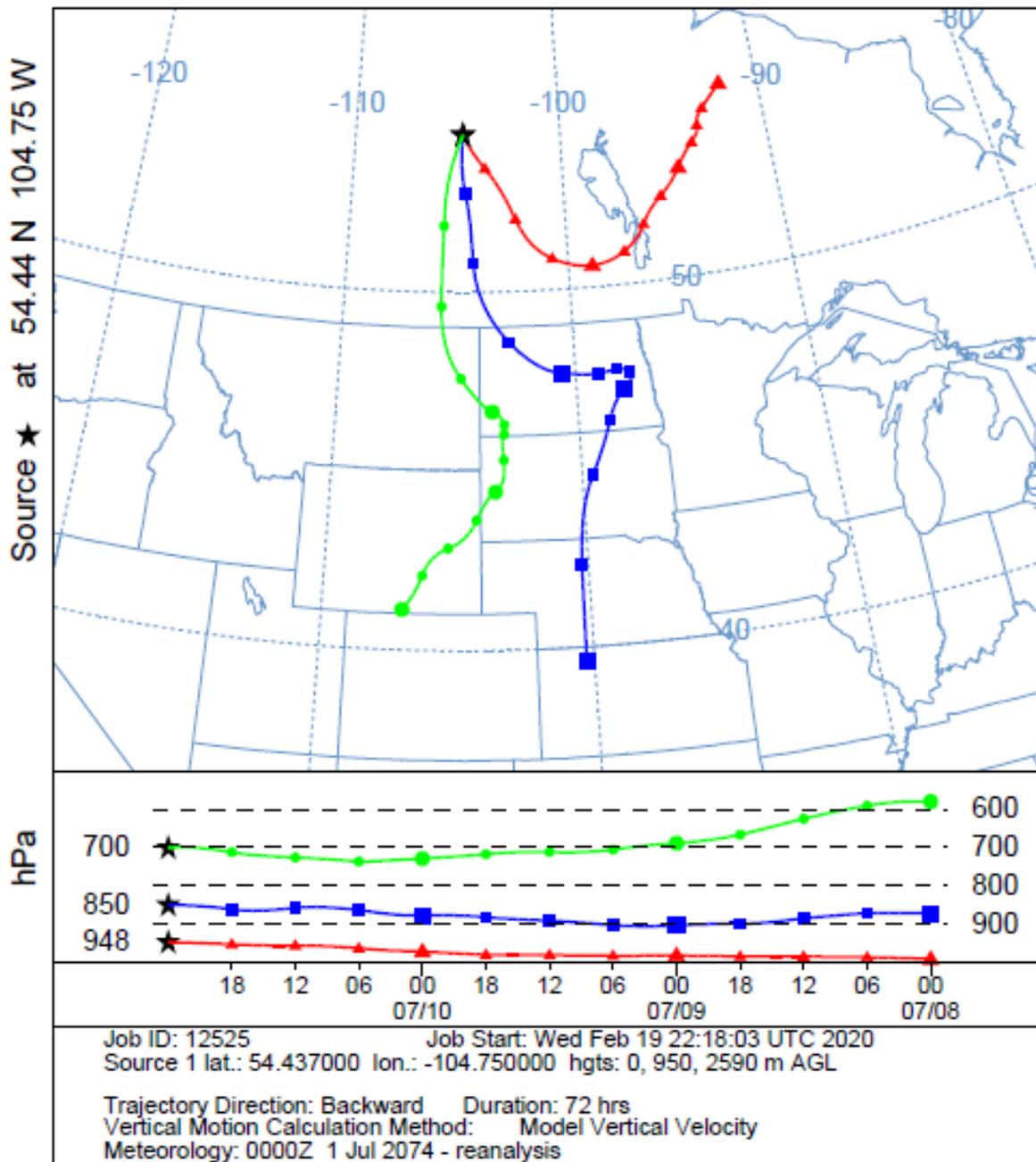
Precipitation (inches)

- | | | | | |
|---------------|---------------|---------------|-----------------|-----------------|
| ■ 0.00 - 1.00 | ■ 3.01 - 4.00 | ■ 6.01 - 7.00 | ■ 9.01 - 10.00 | ■ 12.01 - 13.00 |
| ■ 1.01 - 2.00 | ■ 4.01 - 5.00 | ■ 7.01 - 8.00 | ■ 10.01 - 11.00 | |
| ■ 2.01 - 3.00 | ■ 5.01 - 6.00 | ■ 8.01 - 9.00 | ■ 11.01 - 12.00 | |

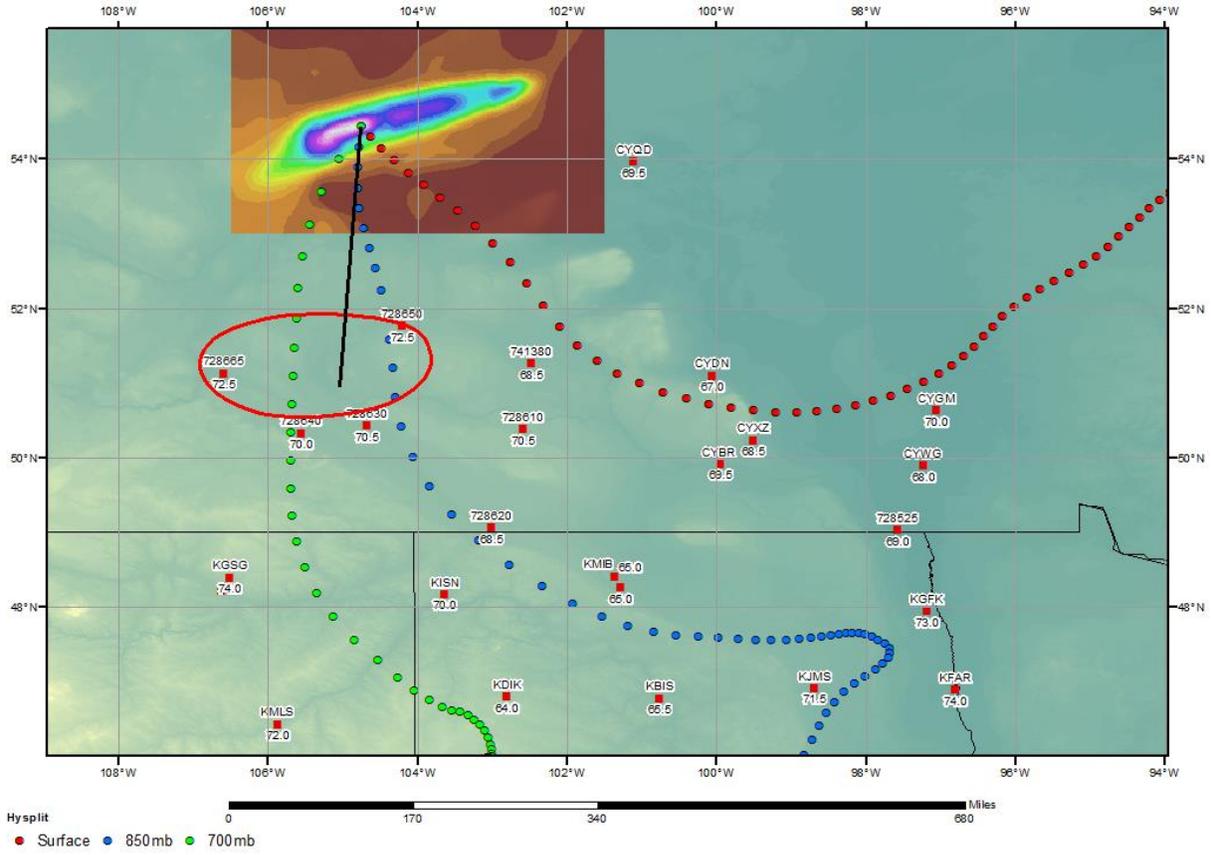


02/21/2020

NOAA HYSPLIT MODEL
 Backward trajectories ending at 0000 UTC 11 Jul 74
 CDC1 Meteorological Data



SPAS 1744 Storm Analysis July 9-10, 1974



Storm Precipitation Analysis System (SPAS) For Storm #1035_1 SPAS Analysis

General Storm Location: Forest City, MN

Storm Dates: June 19 – 22, 1983

Event: Convective Thunderstorm

DAD Zone 1

Latitude: 45.23941

Longitude: -94.54040

Rainfall Amount: 17.00" (Grid/Pixel Point =16.53")

Number of Stations: 515 (h=8, hp=1, d=498 (434 Coop), s=8)

SPAS Version: 2.0

Base Map Used: No

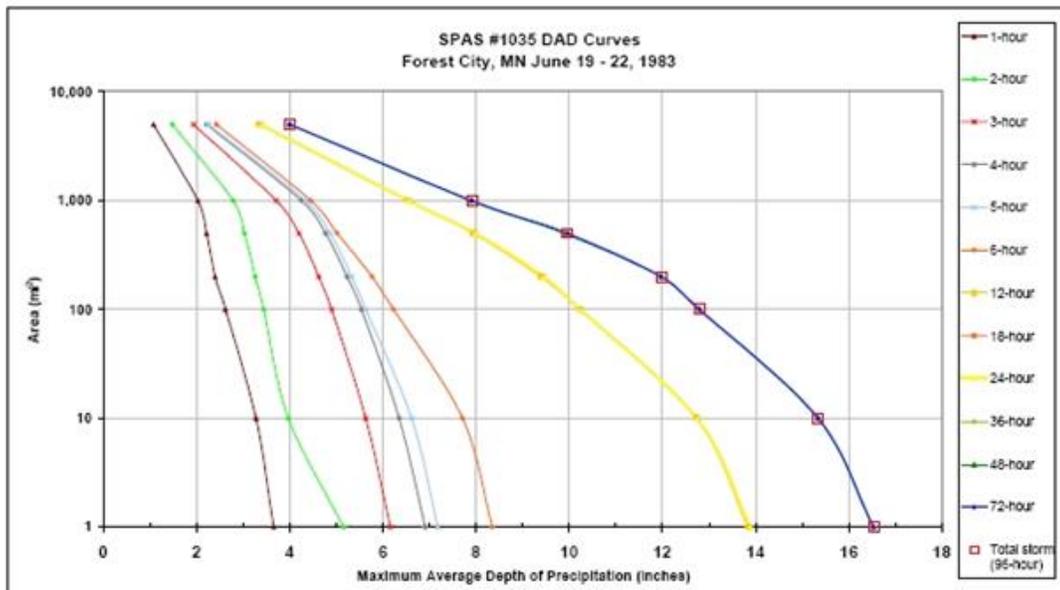
Radar Included: No

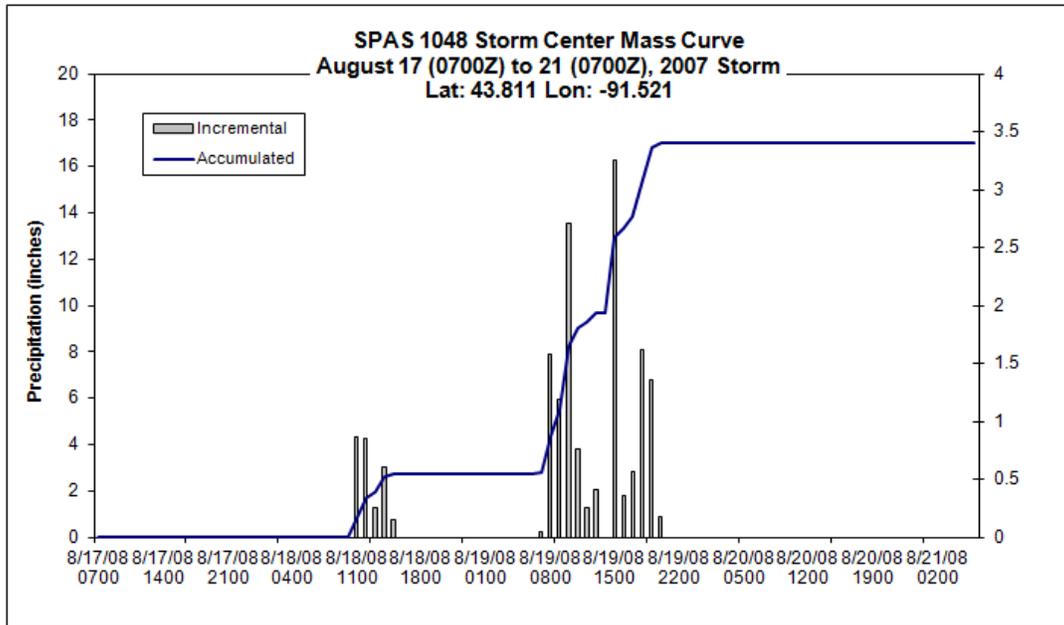
Depth-Area-Duration (DAD) analysis: Yes, 1, 2, 3, 4, 5, 6, 12, 18, 24, 36, 48, 72, and 96 hours.

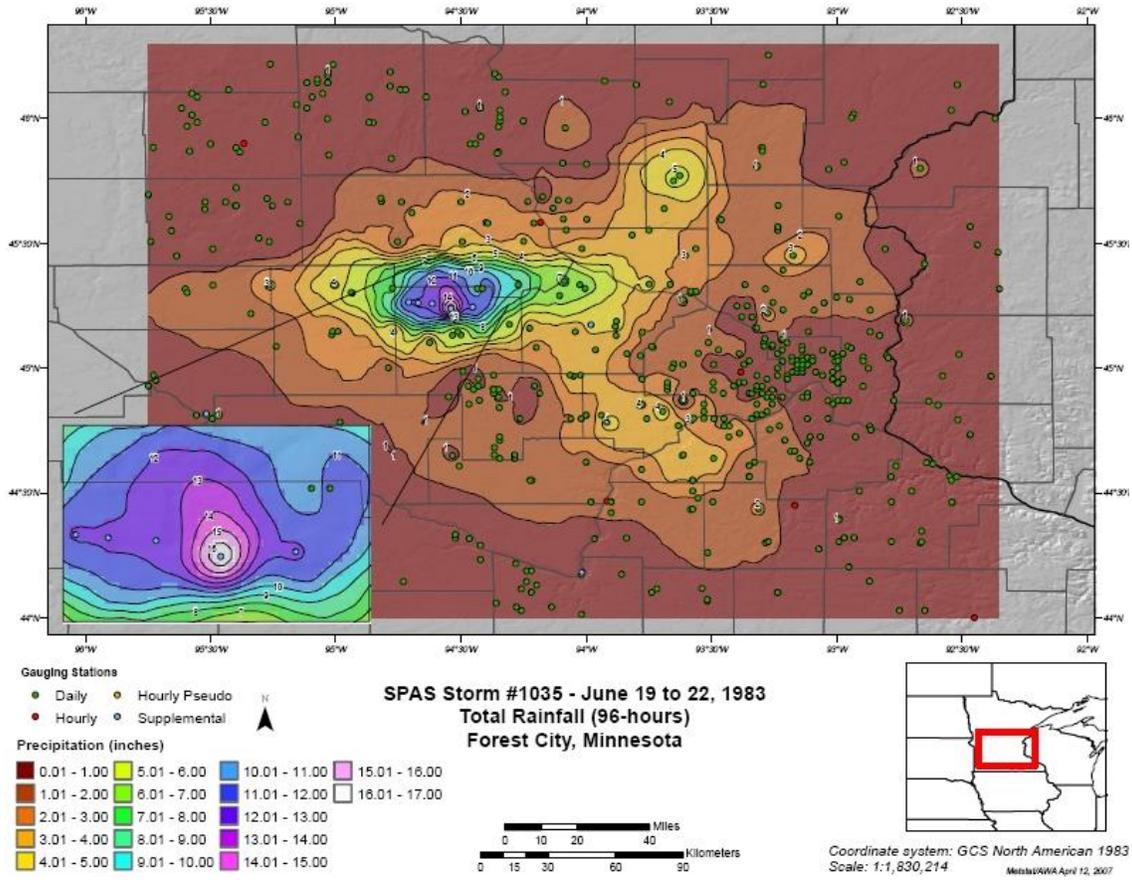
Storm 1035 - Forest City, MN June 19 - 22, 1983

MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

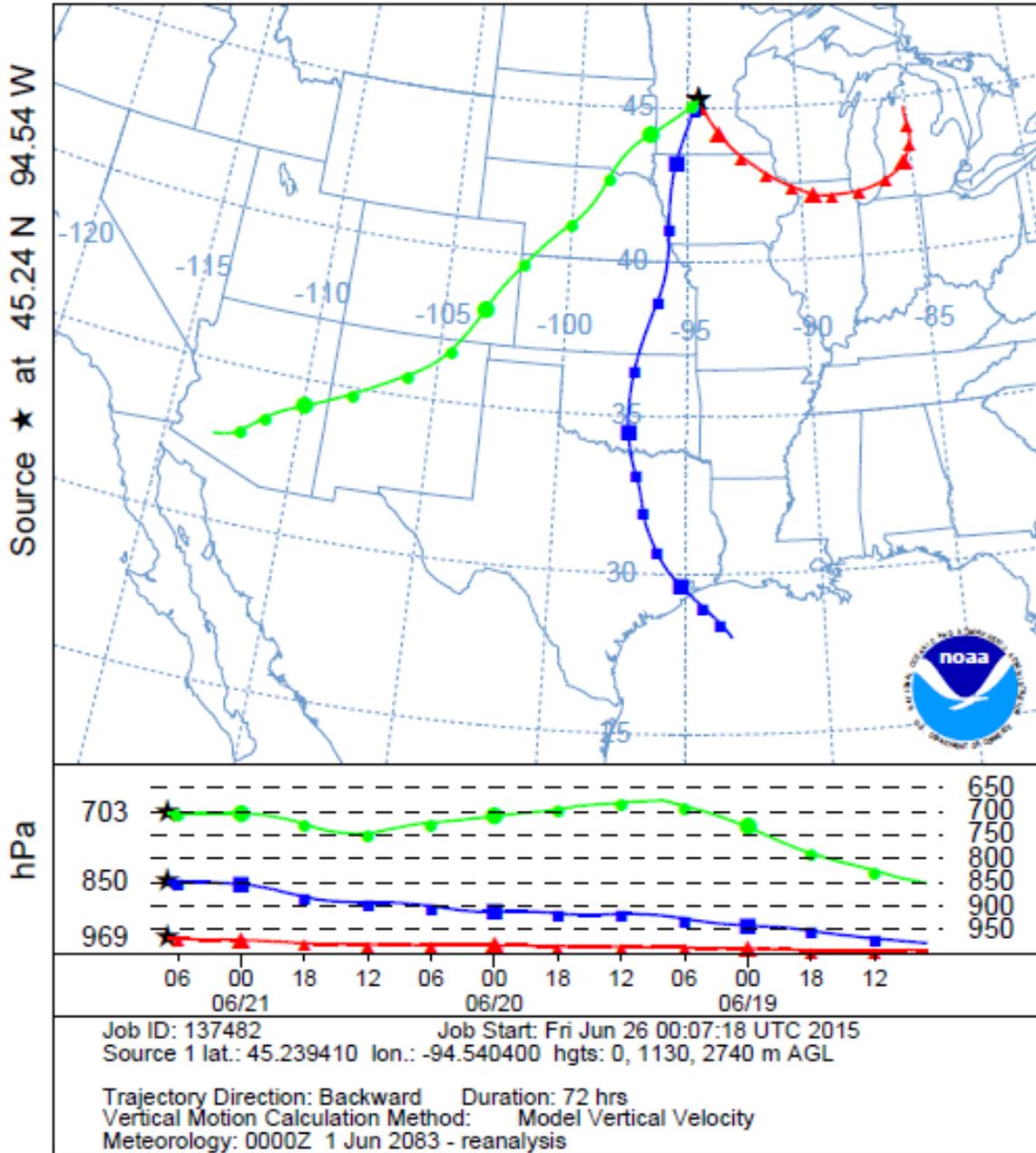
Area (mi ²)	Duration (hours)													
	1	2	3	4	5	6	12	18	24	36	48	72	96	total
1	3.66	5.16	6.16	6.91	7.18	8.38	13.84	13.89	13.89	16.53	16.53	16.53	16.53	16.53
10	3.28	3.97	5.63	6.35	6.62	7.71	12.73	12.74	12.74	15.34	15.34	15.34	15.34	15.34
100	2.62	3.44	4.90	5.54	5.63	6.23	10.23	10.23	10.23	12.79	12.79	12.79	12.79	12.79
200	2.40	3.26	4.62	5.23	5.33	5.77	9.38	9.45	9.45	11.97	11.97	11.97	11.97	11.97
500	2.22	3.03	4.20	4.77	4.87	5.02	7.94	7.98	7.98	9.90	9.90	9.97	9.97	9.97
1,000	2.03	2.79	3.71	4.25	4.33	4.45	6.54	6.55	6.55	7.89	7.89	7.91	7.91	7.91
5,000	1.08	1.48	1.94	2.22	2.26	2.43	3.35	3.38	3.38	4.00	4.00	4.00	4.01	4.01



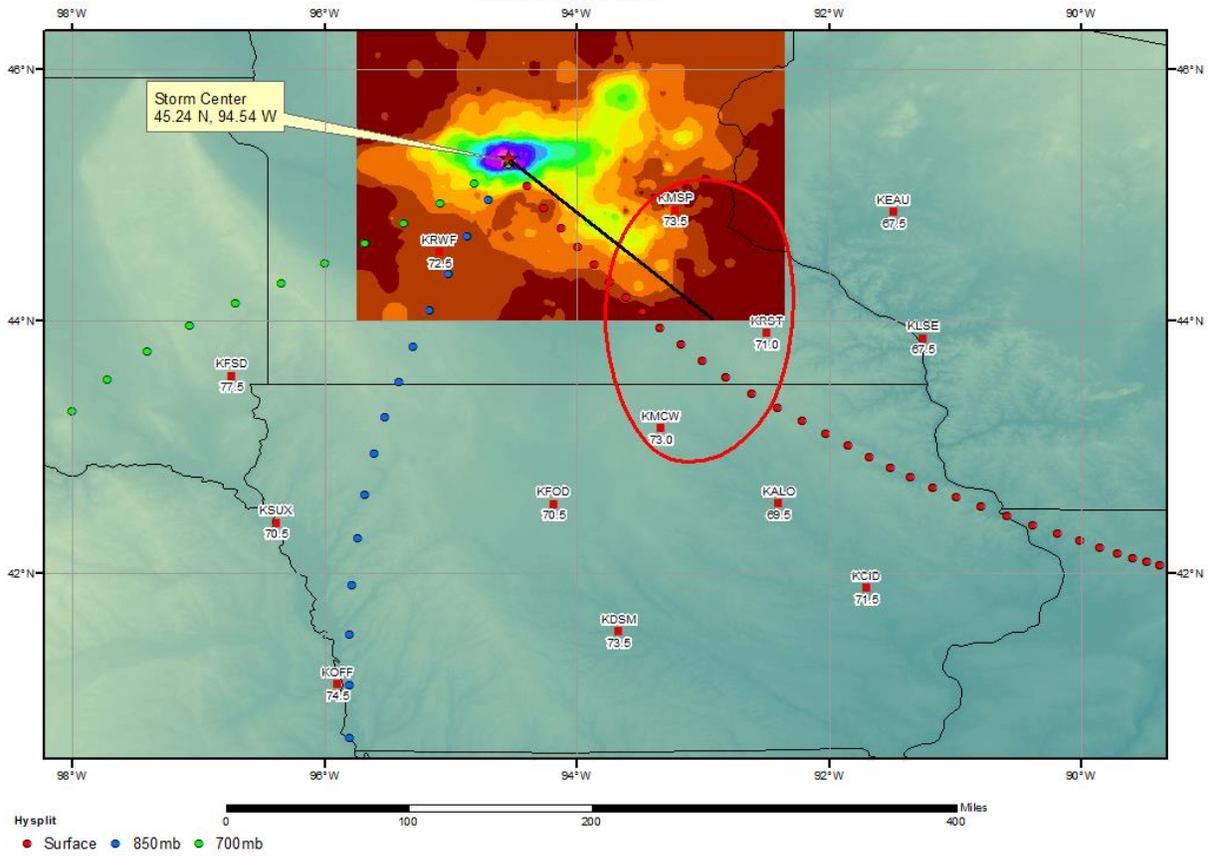




NOAA HYSPLIT MODEL
 Backward trajectories ending at 0700 UTC 21 Jun 83
 CDC1 Meteorological Data



SPAS 1035 Forest City, MN Storm Analysis June 20-21, 1983



Storm Precipitation Analysis System (SPAS) For Storm #1210_1 SPAS Analysis

General Storm Location: Twin Cities, MN

Storm Dates: 07/23/1987 0700 UTC - 07/24/1987 1800 UTC (CPP: 36-hours)

Event: Mesoscale Convective Complex

DAD Zone 1

Latitude: 44.8895

Longitude: -93.40208

Max. Grid Rainfall Amount: 11.55"

Max. Observed Rainfall Amount: 11.32"*** (EDEN PRAIRIE, MN)

Number of Stations: 293 (37 Daily, 8 Hourly, 3 Hourly Pseudo, 245 Supplemental)

SPAS Version: 8.5

Base Map Used: A basemap/grid was created with a blend of the Univ. of Minnesota/MN Climate Center isohyetal, the EPRI isohyetal, a composite of 5 geo-referenced WSR-57 radar images and the SPAS total storm (based on PRISM mean 1971-2000 July Precipitation as a basemap).

Spatial resolution: 15 seconds* (~ 0.25 mi²)

Radar Included: No**

Depth-Area-Duration (DAD) analysis: Yes

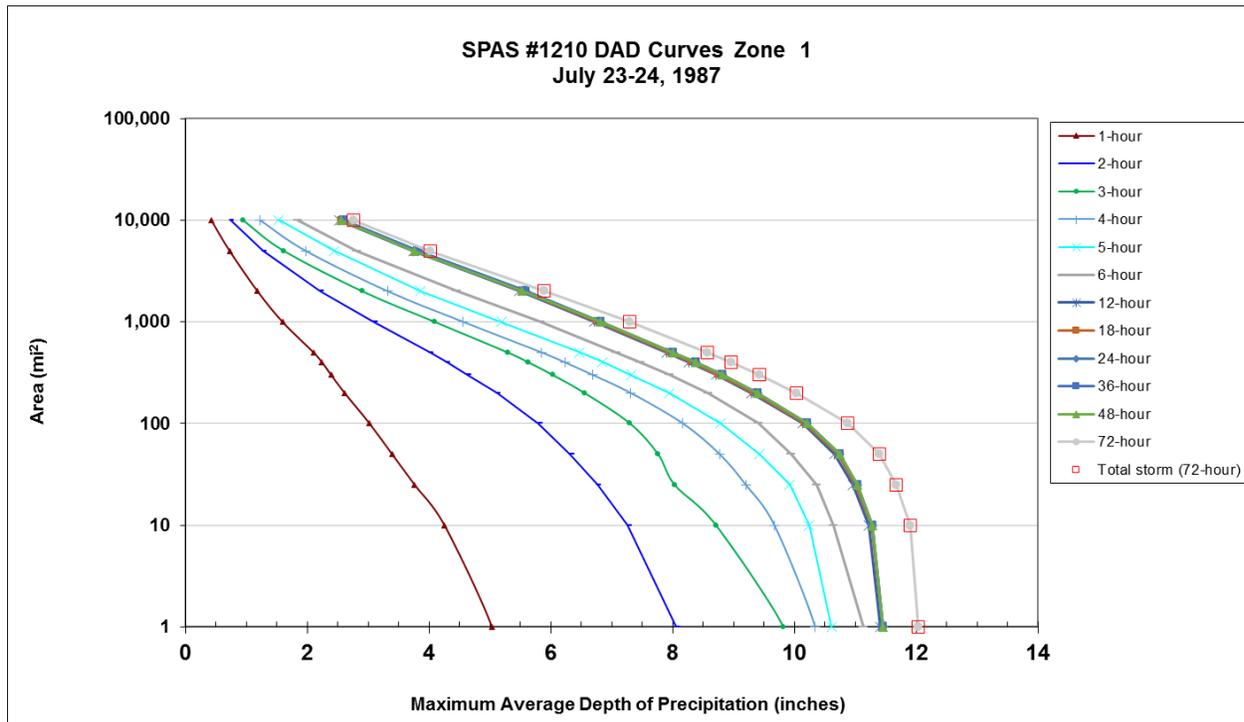
Reliability of results: Although this storm analysis did not use radar data, the abundant gauge data and well positioned hourly rain gauges provided excellent spatial and temporal information and therefore a very high degree of confidence in the final results.

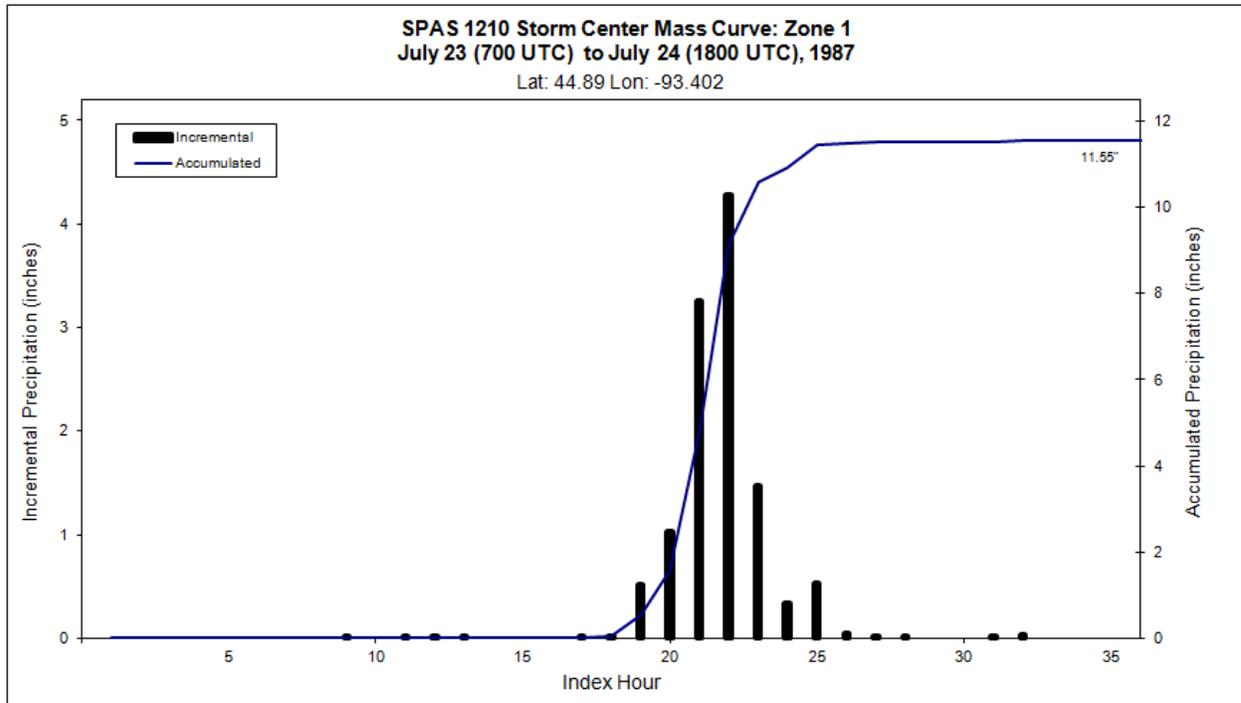
*A higher spatial resolution (15-sec vs. 30-sec) was used in this analysis to better capture the spatial details.

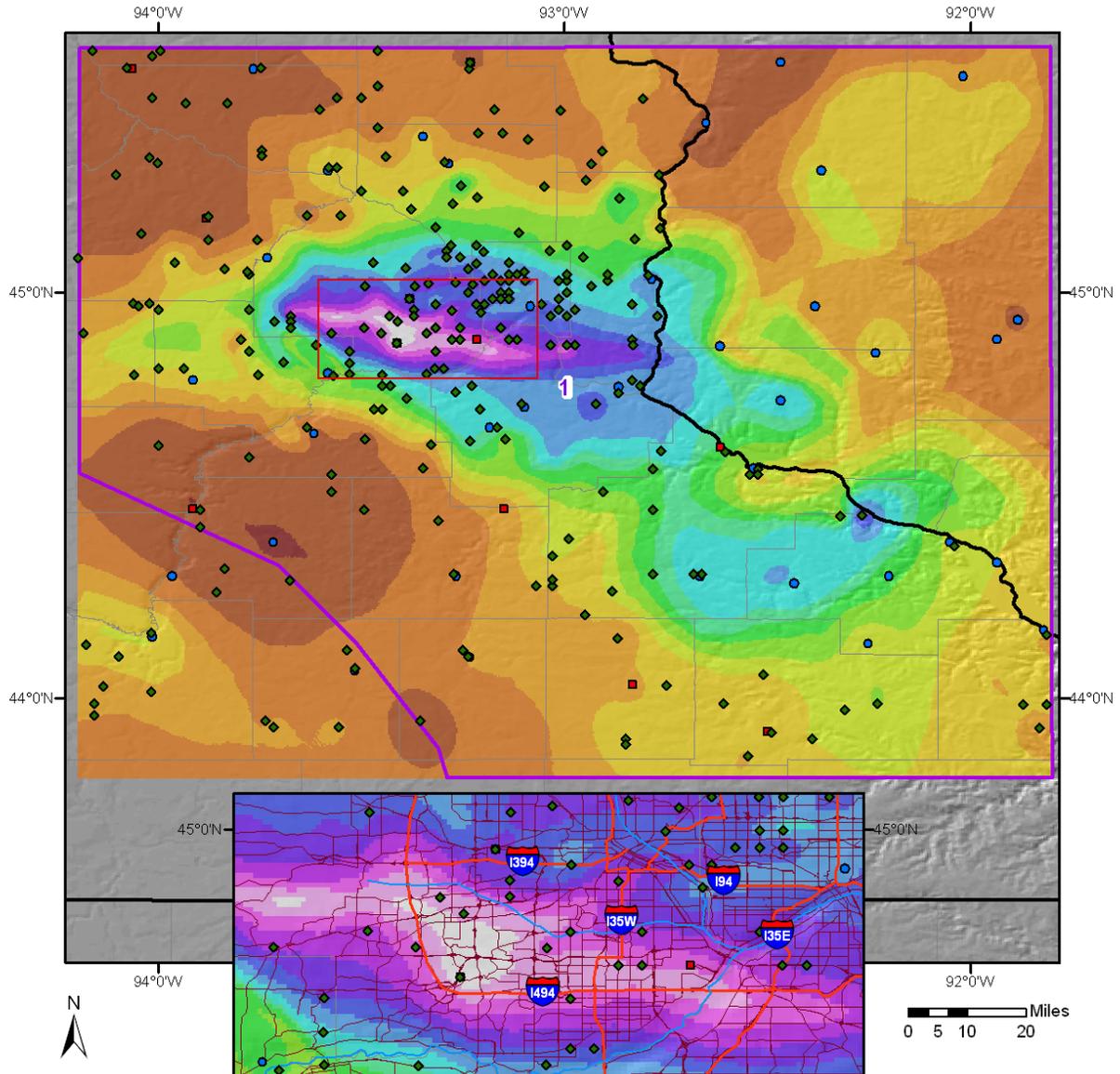
** Although no radar data was used, 5 WSR-57 geo-referenced images provided some useful information. See more details below.

*** Given this station was nudged in the analysis, the 11.32" value won't clearly show up in the av1201.txt file. Furthermore, the CPP was limited to a 36 hour window, whereas this station reported more precip at the very end of the 72-hour analyzed period.

Storm 1210 - July 23 (0700 UTC) - July 24 (1800 UTC), 1987													
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)													
Area (mi ²)	Duration (hours)												
	1	2	3	4	5	6	12	18	24	36	48	72	Total
0.4	5.10	8.12	9.91	10.38	10.67	11.17	11.45	11.48	11.49	11.49	11.49	12.06	12.06
1	5.03	8.06	9.82	10.34	10.61	11.13	11.41	11.46	11.46	11.46	11.46	12.03	12.03
10	4.25	7.26	8.71	9.67	10.24	10.64	11.22	11.27	11.28	11.28	11.28	11.90	11.90
25	3.76	6.76	8.03	9.20	9.92	10.36	10.96	11.01	11.04	11.04	11.04	11.67	11.67
50	3.39	6.32	7.76	8.77	9.43	9.95	10.66	10.71	10.75	10.75	10.75	11.39	11.39
100	3.02	5.80	7.30	8.17	8.79	9.41	10.13	10.16	10.21	10.21	10.21	10.87	10.87
200	2.61	5.11	6.55	7.31	7.94	8.58	9.30	9.34	9.40	9.40	9.40	10.04	10.04
300	2.39	4.63	6.03	6.69	7.32	7.95	8.71	8.75	8.81	8.81	8.81	9.42	9.42
400	2.24	4.28	5.63	6.23	6.85	7.47	8.27	8.31	8.38	8.38	8.38	8.96	8.96
500	2.10	4.01	5.29	5.85	6.47	7.08	7.90	7.95	8.01	8.01	8.01	8.57	8.57
1,000	1.59	3.09	4.09	4.56	5.19	5.83	6.71	6.76	6.82	6.82	6.81	7.29	7.29
2,000	1.18	2.21	2.90	3.32	3.86	4.45	5.48	5.53	5.58	5.58	5.52	5.89	5.89
5,000	0.72	1.27	1.61	1.97	2.44	2.82	3.74	3.78	3.83	3.83	3.76	4.02	4.02
10,000	0.42	0.73	0.94	1.22	1.53	1.84	2.53	2.56	2.60	2.60	2.56	2.75	2.75







ISOHYETAL FROM SPAS #1210 - "Twin Cities Super Storm"
Total 36-hour Rainfall (inches)
07/23/1987 0700 UTC - 07/24/1987 1800 UTC

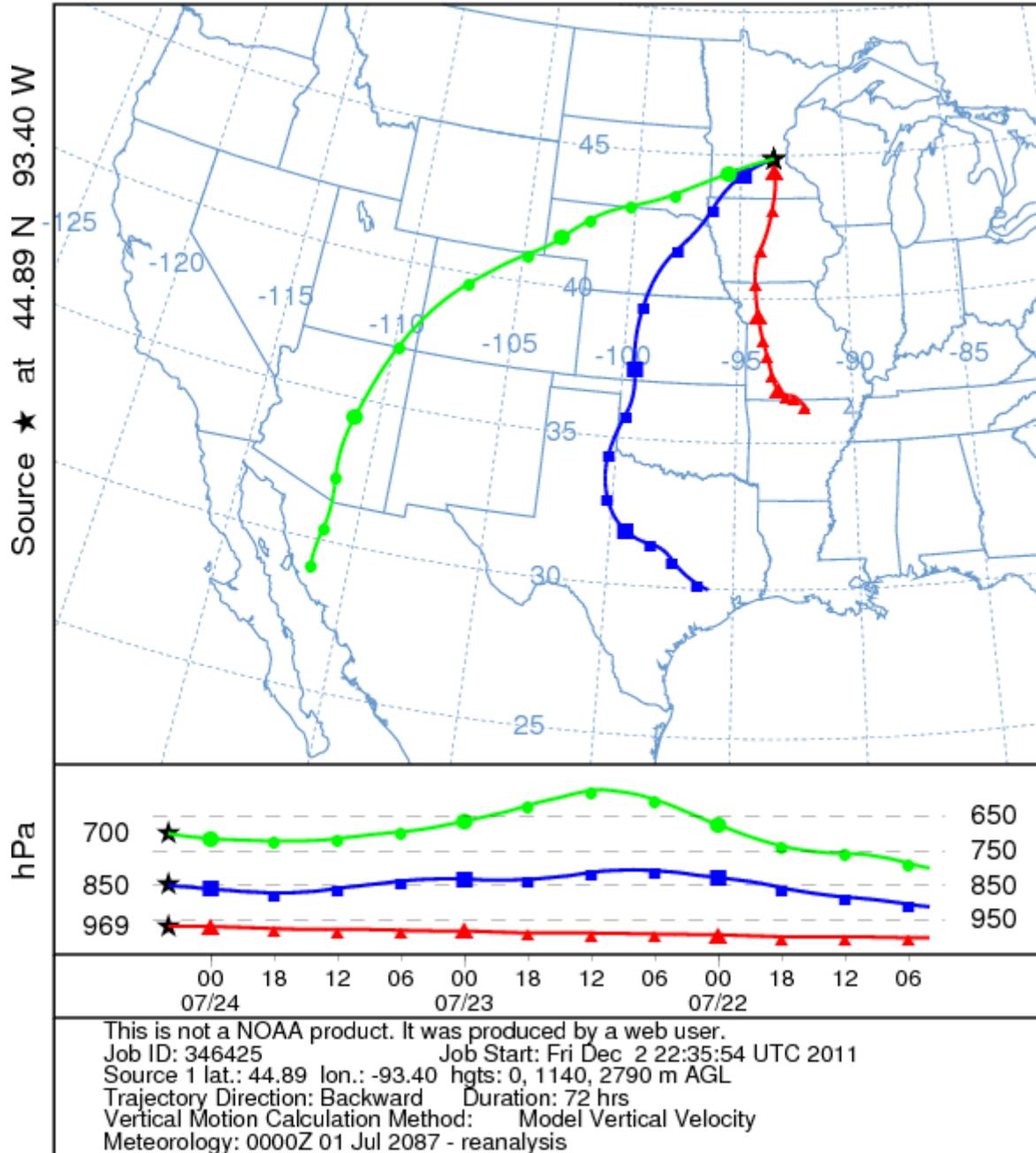
Inches

- | | | |
|---------------|---------------|-----------------|
| ■ ≤ 0.02 | ■ 2.51 - 3.00 | ■ 7.01 - 8.00 |
| ■ 0.03 - 0.50 | ■ 3.01 - 3.50 | ■ 8.01 - 9.00 |
| ■ 0.51 - 1.00 | ■ 3.51 - 4.00 | ■ 9.01 - 10.00 |
| ■ 1.01 - 1.50 | ■ 4.01 - 5.00 | ■ 10.01 - 11.00 |
| ■ 1.51 - 2.00 | ■ 5.01 - 6.00 | ■ 11.01 - 11.55 |
| ■ 2.01 - 2.50 | ■ 6.01 - 7.00 | ■ dadzones_1210 |

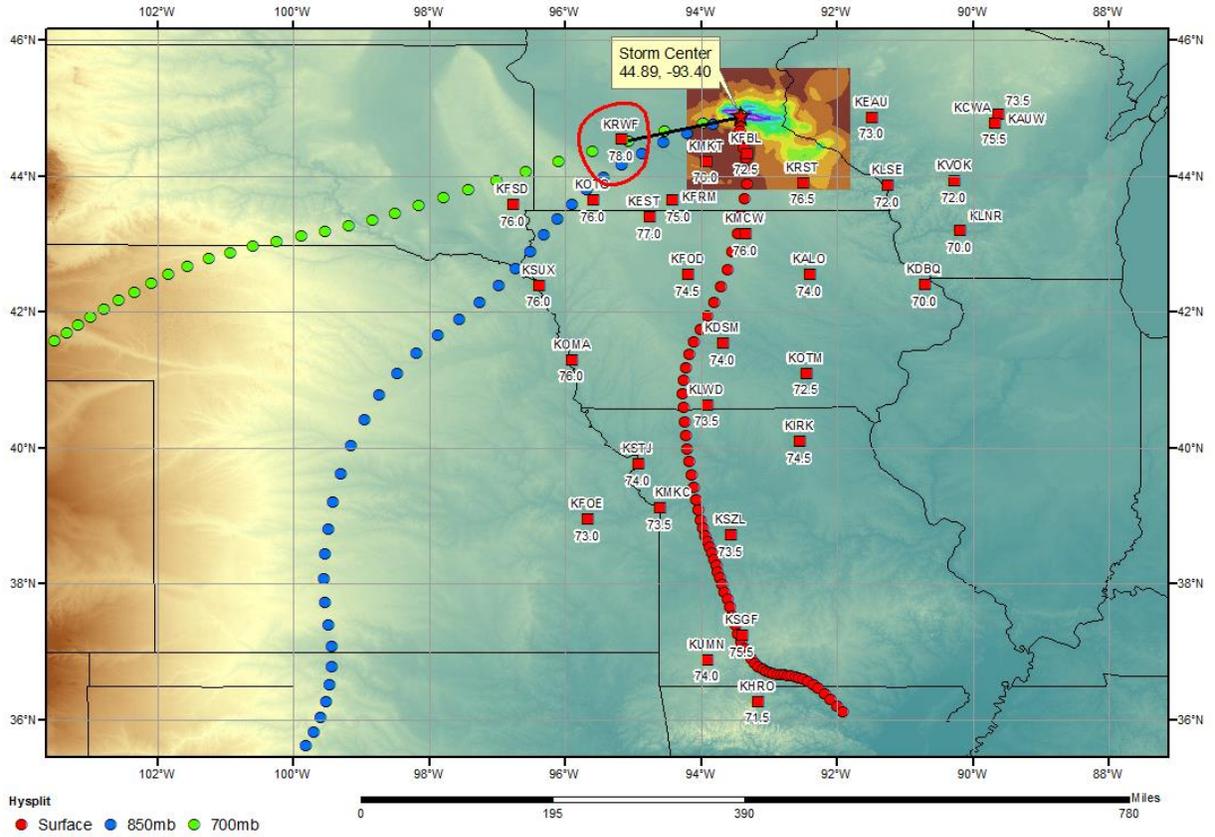
- Daily
- Hourly
- Hourly Pseudo
- ◆ Supplemental



NOAA HYSPLIT MODEL
 Backward trajectories ending at 0400 UTC 24 Jul 87
 CDC1 Meteorological Data



Minneapolis, MN Storm Analysis July 21-24, 1987



Storm Precipitation Analysis System (SPAS) For Storm #1673_1 SPAS Analysis

Storm analysis domain: Harrow, Ontario (-83.2, 42.4, 41.7, -82.4)

Storm dates: July 19 – July 20, 1989

Event: Mid-latitude cyclone (MLC) with embedded convection and local orographic-induced convergence

SPAS version: 10 (See Appendix A for a brief description of SPAS)

Base map used: Digitized version of the isohyetal map from Figure 3 of the Environment Canada Harrow Storm Study

Grid cell resolution (sqmi): 0.2465

Radar included: No

Number of stations: 36 stations

Gauge Type	Description	Abbr.*	No. of stations
Hourly	Hourly gauges with complete or nearly complete, incremental hourly precipitation data	H	3
Hourly estimated	Hourly gauges with some estimated hourly values, but otherwise reliable	HE	0
Hourly pseudo	Hourly gauges with reliable temporal precipitation data, but the magnitude is questionable in relation to co-located daily or supplemental gauges	HP	0
Hourly estimated pseudo	Combination of hourly estimated and hourly pseudo	HEP	0
Daily	Daily gauge with complete data and known observation times	D	0
Daily estimated	Daily gauges with some or all estimated data	DE	0
Supplemental	Gauges with unknown or irregular observation times, but reliable precipitation data	S	33
Supplemental estimated	Gauges with estimated precipitation values based on other information such as radar, pre-existing total storm isohyetal maps or public storm reports	SE	0

*Stations abbreviated with the letter O imply the station was omitted from the analysis.

Depth-Area-Duration				
	Zone 1			
Latitude	42.0042			
Longitude	-82.9375			
Maximum grid precipitation amount:	17.74			

Maximum observed precipitation amount:	17.75			
Maximum observed precipitation location:	HARROW AG CENTER, ONTARIO			
Maximum 24-hour 100sqmi precipitation amount:	12.75			

Reliability of results:

In addition to the handful of NCDC stations, 33 supplemental stations were created in ArcGIS by digitizing the bucket survey stations in Figure 3 of the Environment Canada Harrow Storm Study. These stations were added to the SPAS analysis to ensure that the data more closely resemble what was observed and reported during this storm event. In addition to this, the isohyets in Figure 3 were digitized, converted to a raster grid, and used as a basemap for the SPAS analysis.

Results:

The results of this analysis are provided among several deliverables in separate files. Appendix B contains a list of deliverables associated with this analysis.

Data mining

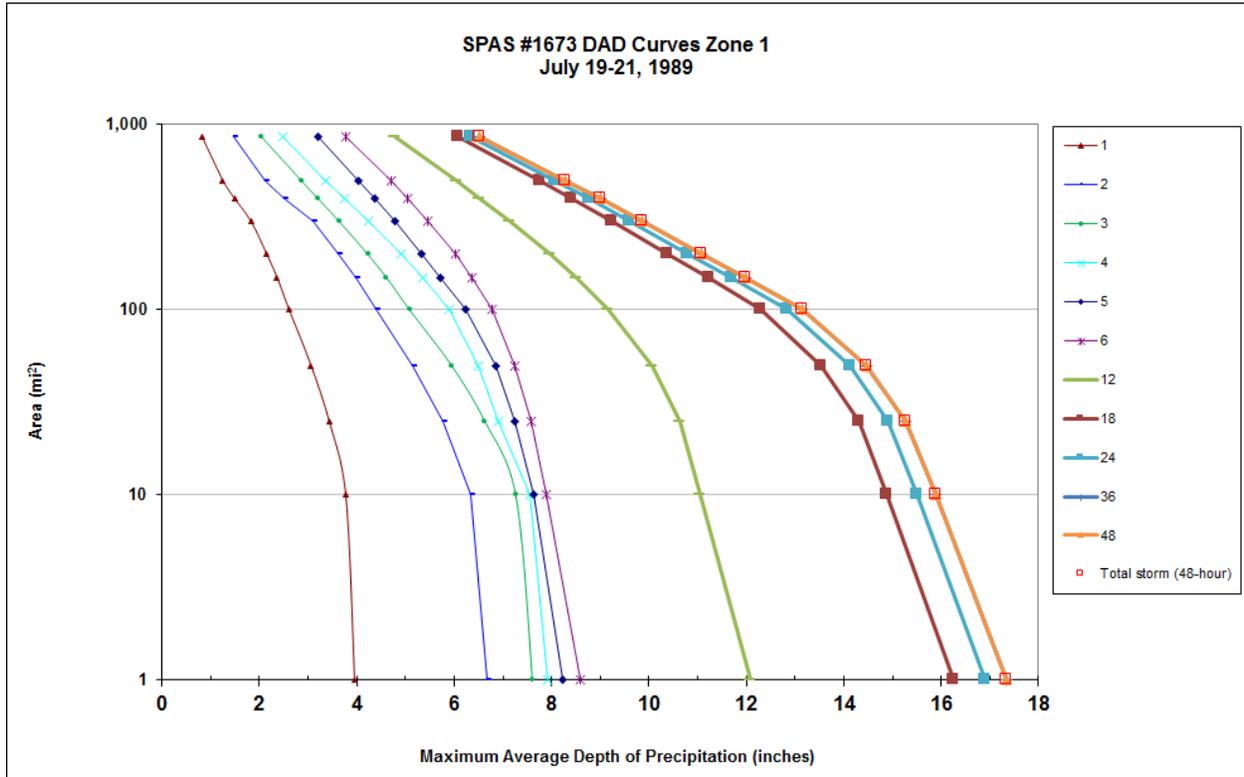
Rain gauge data from the following sources is used in this analysis:

- NCDC – Standard/official daily and hourly precipitation data
- Harrow Storm Report – 33 of the bucket survey locations in Figure 3 of this report were digitized and added as supplemental precipitation stations
- Harrow Storm Report – The isohyets in Figure 3 of this report were used as the basemap for the SPAS analysis
- Checked Local Climatological Data (LCD), Hourly Precipitation Data (HP), and Climatological Data (CD) records in nearby Michigan for any relevant data that could be used in the determining the timing and magnitude of this storm
- Checked Environment Canada sources for any pertinent storm data

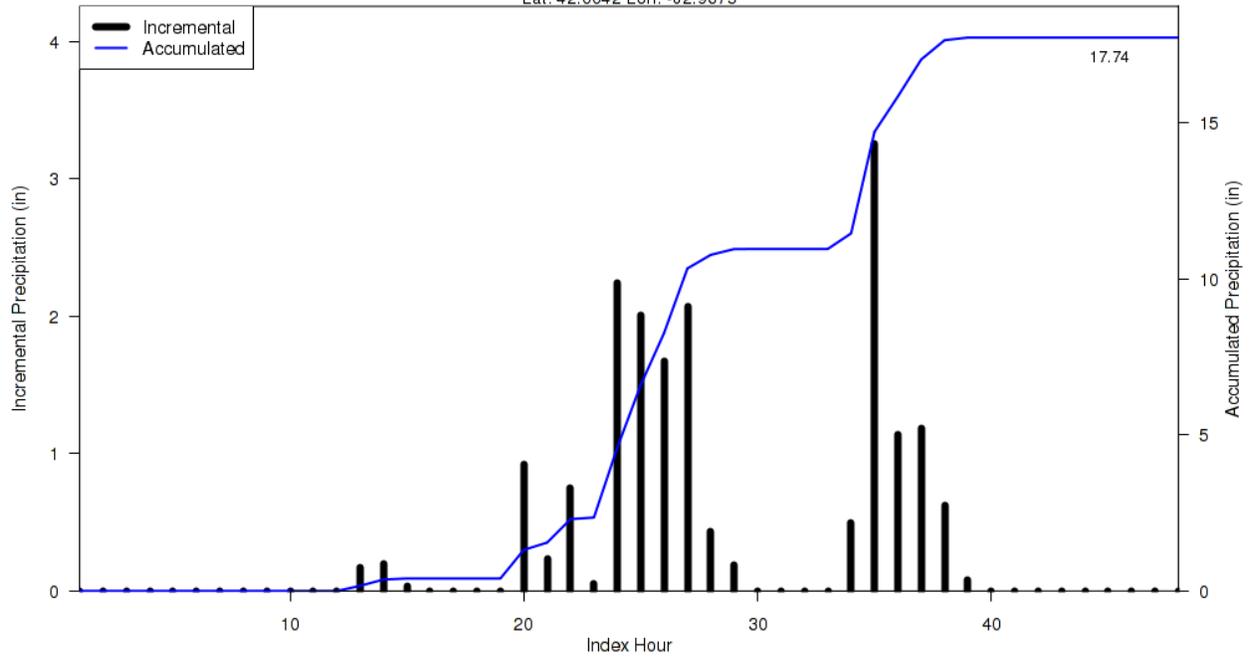
Storm summary and relevant documents

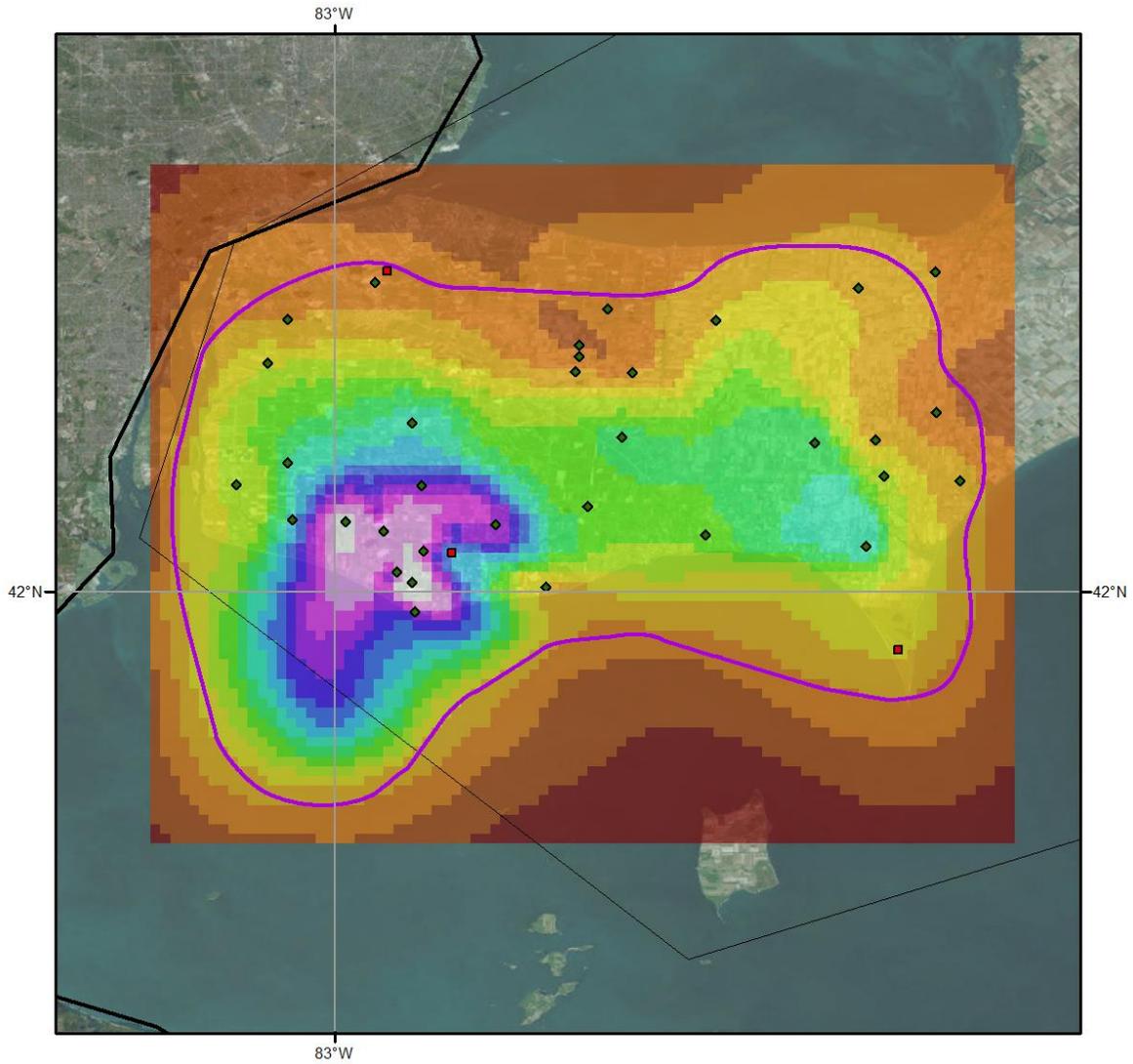
See the report, Gruniewski, P.N., Hogg, W.D., Chen, P., Fox, R.A., and Cameron, I., *Harrow Storm of July 19-20, 1989*, for a detailed account of the synoptic, mesoscale, and local orographic factors contributing to this extreme rainfall event.

Storm 1673 Zone 1 - July 19 (0500 UTC) - July 21 (0400 UTC), 1989												
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)												
areasqmi	Duration (hours)											
	1	2	3	4	5	6	12	18	24	36	48	Total
0.4	3.98	6.71	7.65	7.97	8.35	8.72	12.26	16.50	17.21	17.60	17.60	17.60
1	3.95	6.67	7.60	7.92	8.23	8.59	12.08	16.25	16.89	17.33	17.33	17.33
10	3.77	6.35	7.26	7.56	7.63	7.88	11.05	14.87	15.51	15.88	15.88	15.88
25	3.43	5.77	6.63	6.92	7.24	7.57	10.63	14.30	14.91	15.27	15.27	15.27
50	3.06	5.15	5.95	6.50	6.86	7.25	10.06	13.53	14.13	14.47	14.47	14.47
100	2.61	4.40	5.09	5.90	6.23	6.77	9.16	12.30	12.83	13.15	13.15	13.15
150	2.36	3.97	4.61	5.36	5.72	6.37	8.50	11.22	11.70	11.99	11.99	11.99
200	2.15	3.63	4.23	4.91	5.34	6.02	7.98	10.38	10.80	11.07	11.07	11.07
300	1.83	3.09	3.65	4.24	4.79	5.45	7.14	9.24	9.60	9.85	9.85	9.85
400	1.49	2.52	3.21	3.75	4.36	5.05	6.51	8.42	8.76	9.00	9.00	9.00
500	1.25	2.12	2.87	3.36	4.04	4.71	6.06	7.75	8.06	8.28	8.28	8.28
864	0.82	1.48	2.05	2.47	3.21	3.78	4.79	6.09	6.35	6.53	6.53	6.53



SPAS 1673 Storm Center Mass Curve Zone 1
July 19 (0500UTC) to July 21 (0400UTC), 1989
Lat: 42.0042 Lon: -82.9375





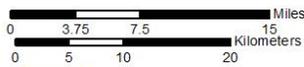
Gauges

- H
- ◆ S

**Total Storm (48-hours) Precipitation (inches)
July 19 - 20, 1989
SPAS 1673 - Harrow, ON**

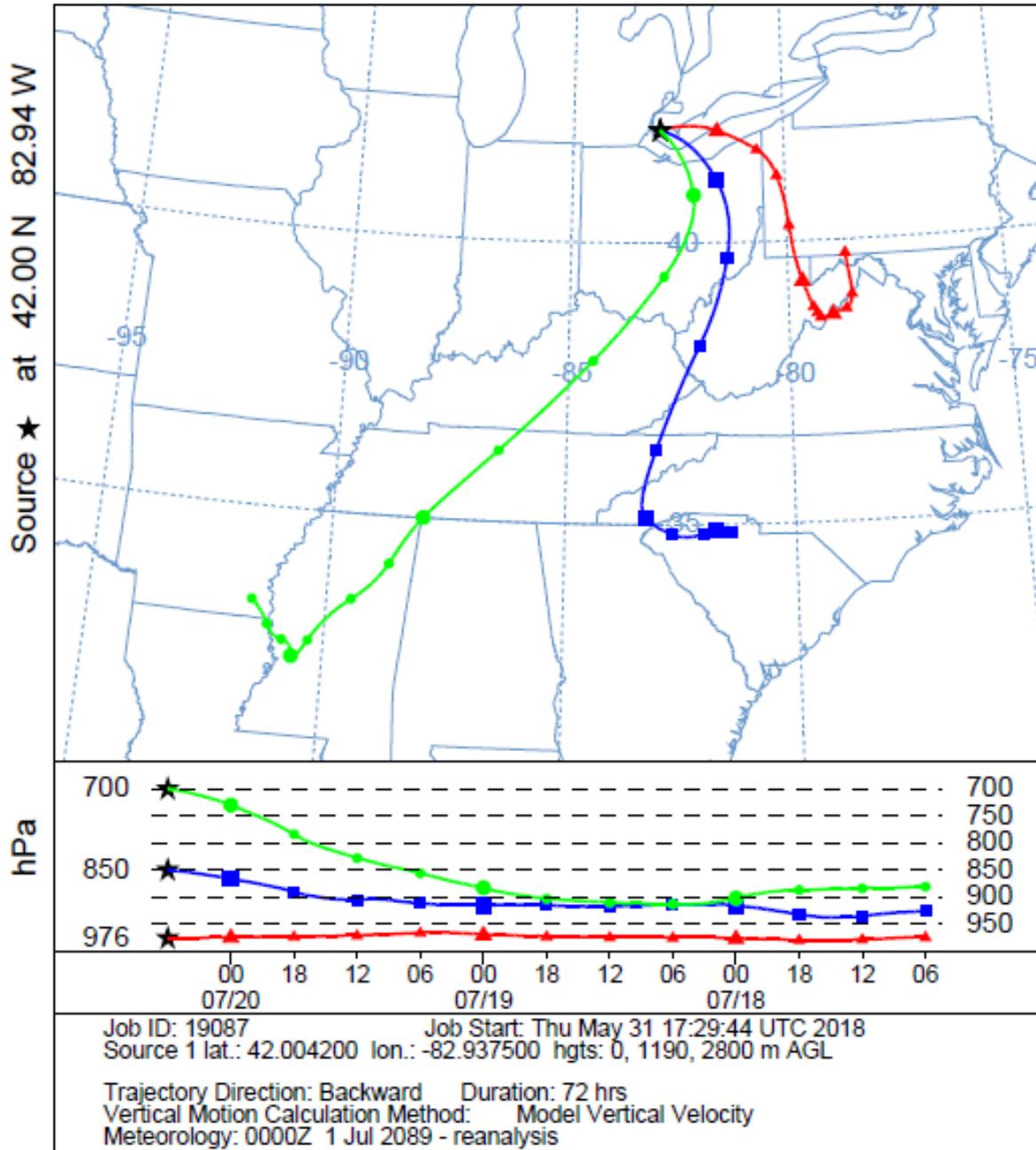
Precipitation (Inches)

<ul style="list-style-type: none"> ■ 0.82 - 2.07 ■ 2.08 - 2.87 ■ 2.88 - 3.60 ■ 3.61 - 4.46 ■ 4.47 - 5.32 	<ul style="list-style-type: none"> ■ 5.33 - 6.25 ■ 6.26 - 7.18 ■ 7.19 - 8.11 ■ 8.12 - 9.11 ■ 9.12 - 10.23 ■ 10.24 - 11.36 	<ul style="list-style-type: none"> ■ 11.37 - 12.36 ■ 12.37 - 13.35 ■ 13.36 - 14.41 ■ 14.42 - 15.61 ■ 15.62 - 17.76
---	---	---

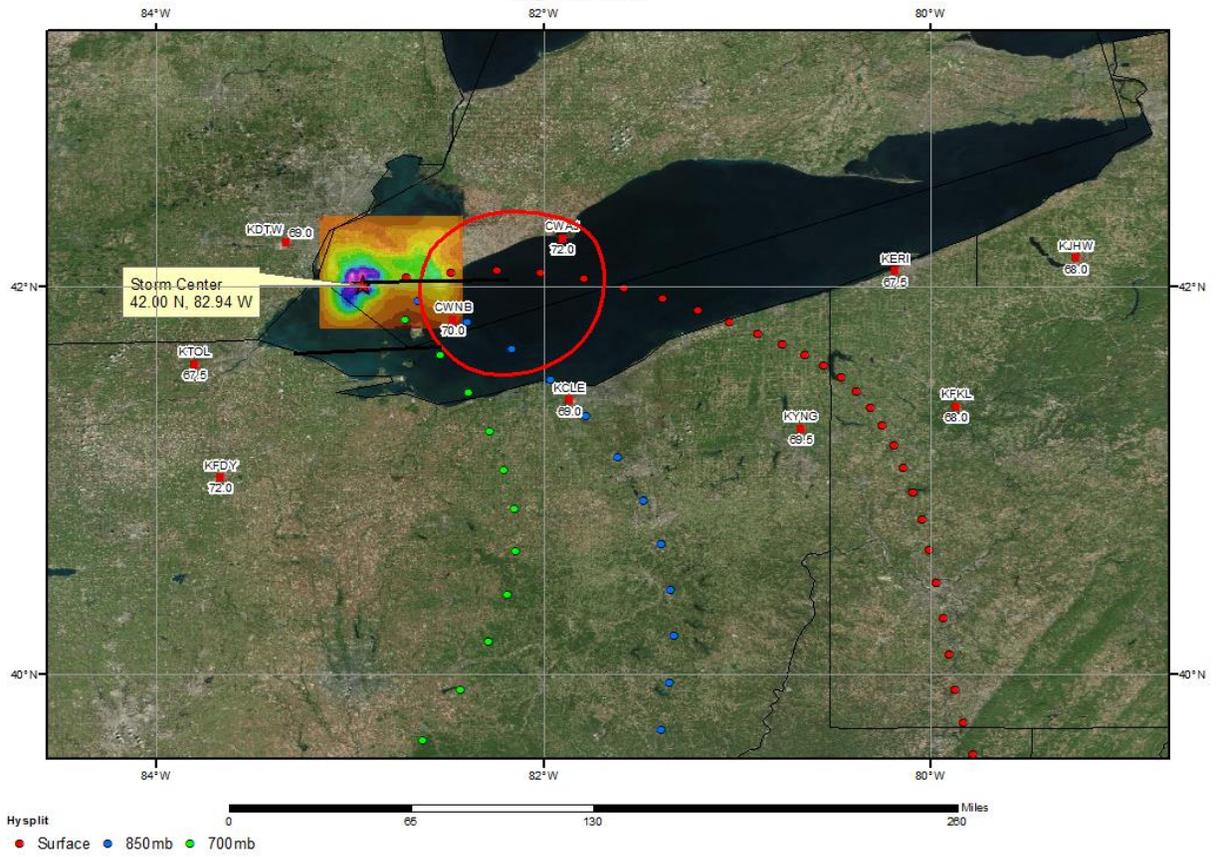


3/4/2018

NOAA HYSPLIT MODEL
 Backward trajectories ending at 0600 UTC 20 Jul 89
 CDC1 Meteorological Data



SPAS 1673 Harrow, ON Storm Analysis July 19, 1989



Storm Precipitation Analysis System (SPAS) For Storm #1036_1 SPAS Analysis

General Storm Location: Pawnee Creek, CO

Storm Dates: July 29 (2000 Z) – 30 (1300 Z), 1997

Event: Convective Thunderstorm

DAD Zone 1

Latitude: 40.7752

Longitude: -103.6253

Rainfall Amount: 13.58" (Grid/Pixel Point) in 12hours (but the total analysis window was 17hrs)

Number of Stations: 96 (15-hourly, 1-hourly pseudo, 24-daily, and 56-supplemental) gauging stations within the define search domain. 77 (6-hourly, 0-hourly pseudo, 15-daily, and 56-supplemental) stations within radar domain.

SPAS Version: 2.0

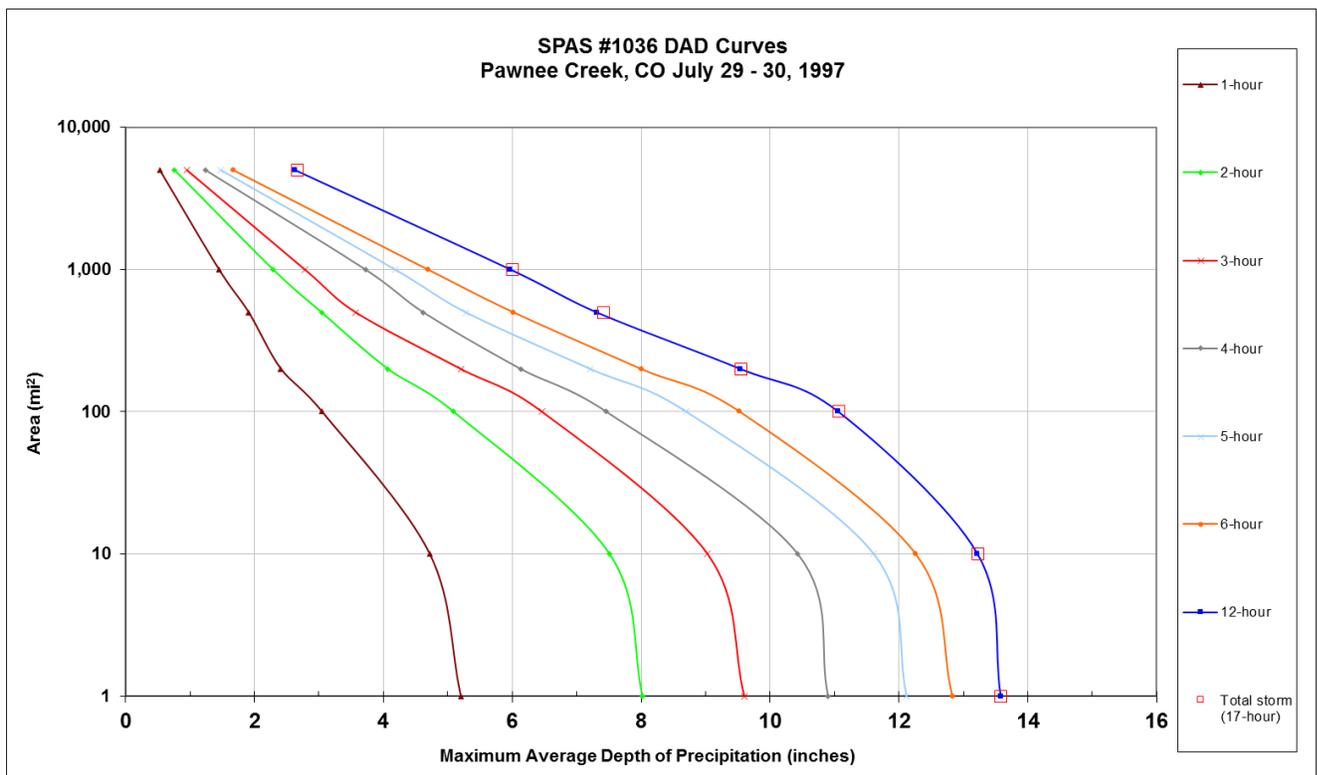
Base Map Used: No

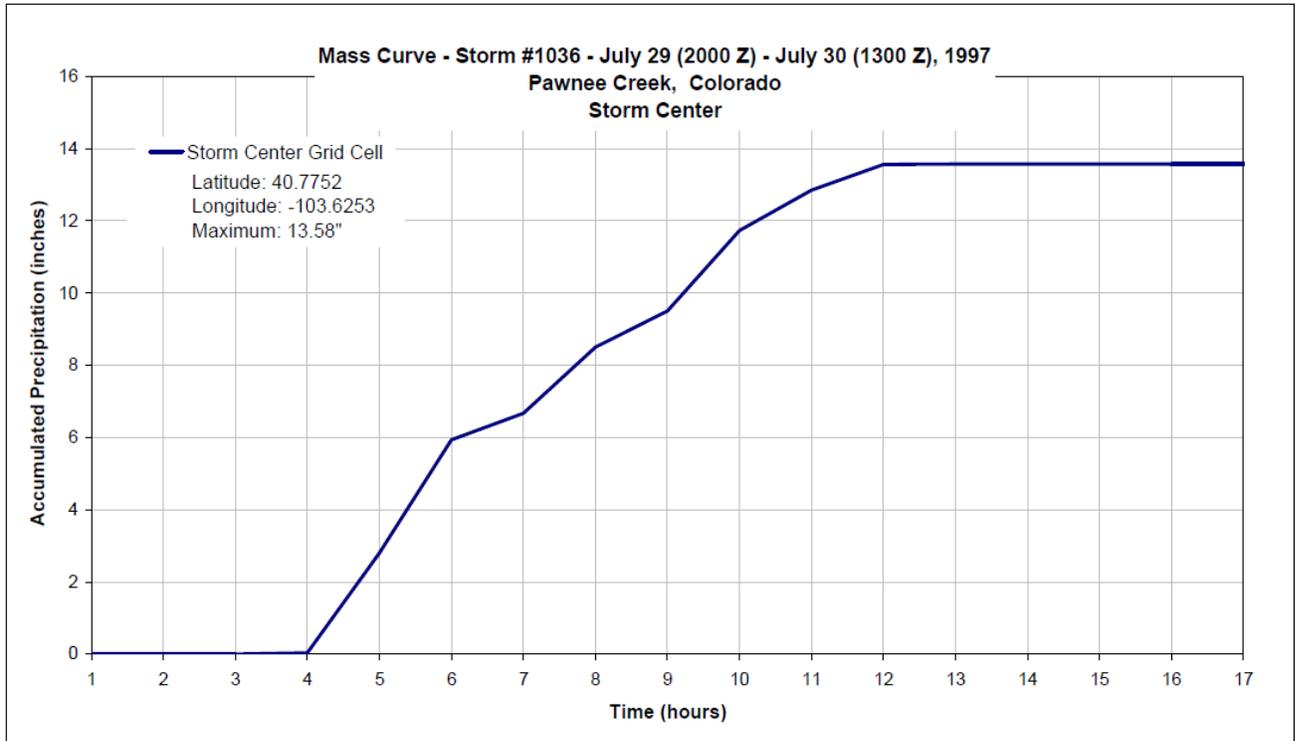
Radar Included: Yes

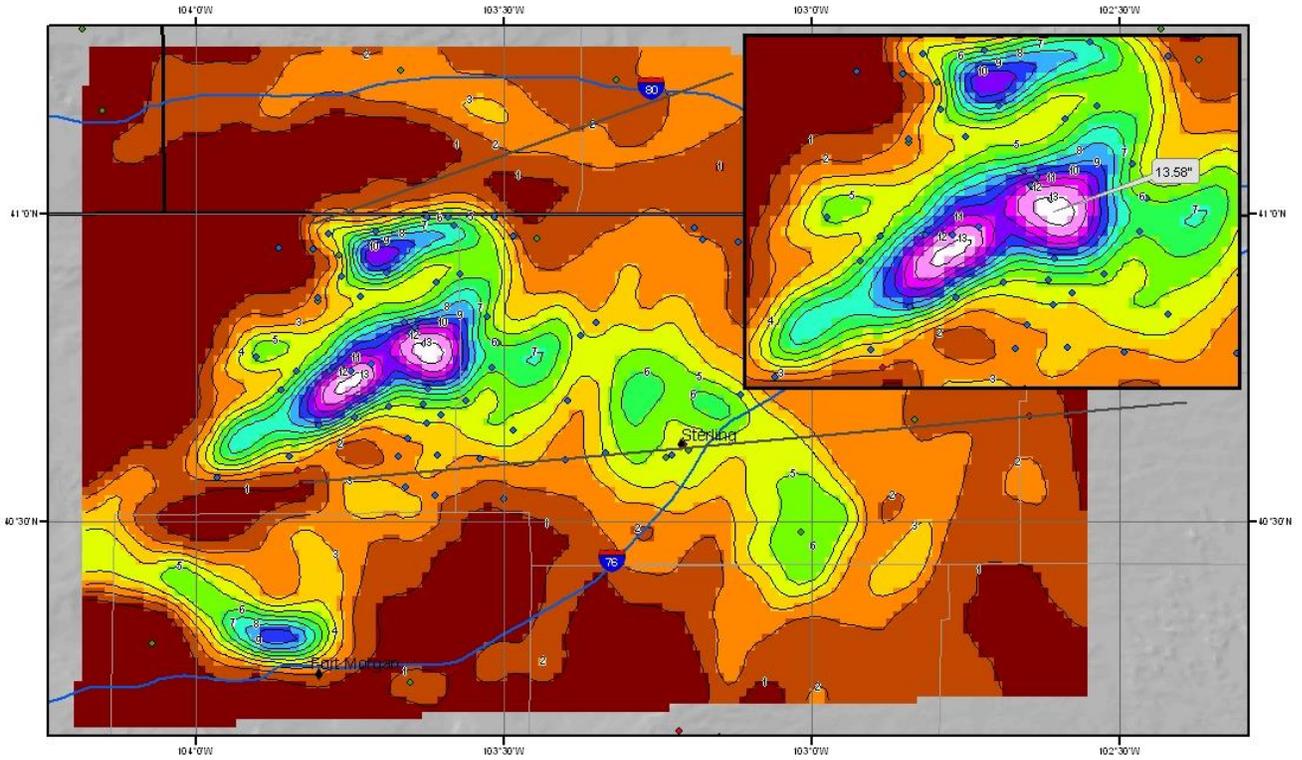
Depth-Area-Duration (DAD) analysis: Yes, 1, 2, 3, 4, 5, 6, 12, and 17 hours.

Storm 1036 - Pawnee Creek, CO July 29 - 30, 1997
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

Area (mi ²)	Duration (hours)								
	1	2	3	4	5	6	12	17	total
1	5.20	8.02	9.60	10.90	12.12	12.83	13.58	13.58	13.58
10	4.72	7.51	9.03	10.43	11.61	12.26	13.22	13.23	13.23
100	3.05	5.09	6.46	7.46	8.70	9.53	11.06	11.07	11.07
200	2.41	4.07	5.20	6.13	7.21	8.00	9.54	9.55	9.55
500	1.91	3.04	3.57	4.62	5.28	6.02	7.31	7.42	7.42
1,000	1.45	2.29	2.78	3.72	4.18	4.69	5.97	6.01	6.01
5,000	0.53	0.76	0.95	1.24	1.48	1.67	2.63	2.67	2.67







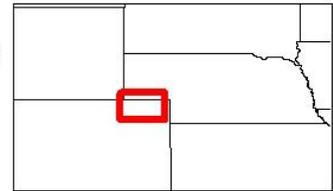
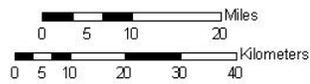
SPAS Storm #1036 - July 29-30, 1997
Total Rainfall (17-hours) - Pawnee Creek, Colorado

Gauging Stations

- ◆ Daily
- ◆ Hourly
- ◆ Hourly Pseudo
- ◆ Supplemental

Precipitation (inches)

0.00 - 1.00	4.01 - 5.00	8.01 - 9.00	12.01 - 13.00
1.01 - 2.00	5.01 - 6.00	9.01 - 10.00	13.01 - 14.00
2.01 - 3.00	6.01 - 7.00	10.01 - 11.00	
3.01 - 4.00	7.01 - 8.00	11.01 - 12.00	

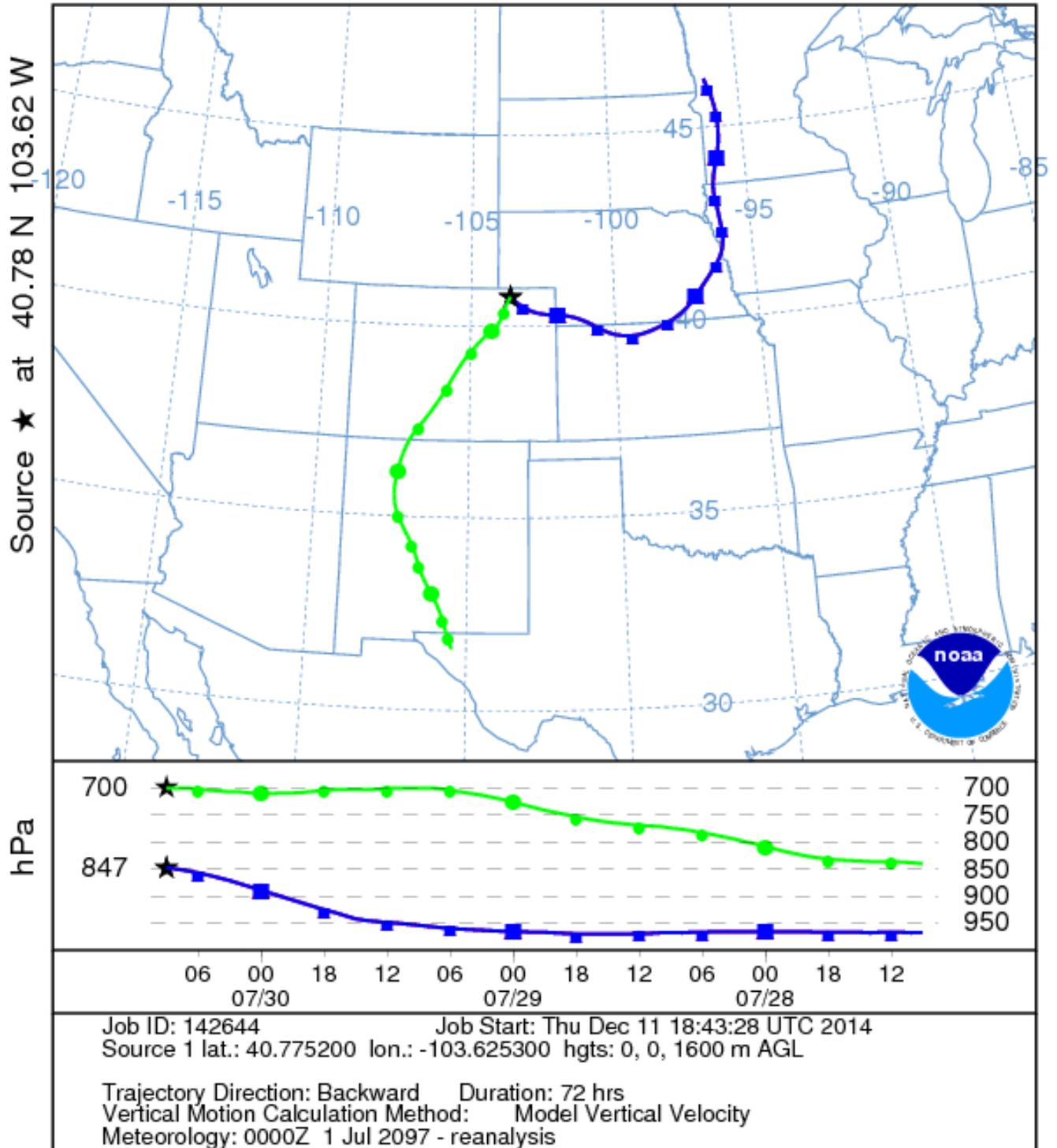


Coordinate system: GCS North American 1983
 Scale: 1:841,717
AR 5527114 June 5, 2007

NOAA HYSPLIT MODEL

Backward trajectories ending at 0900 UTC 30 Jul 97

CDC1 Meteorological Data



Storm Precipitation Analysis System (SPAS) For Storm #1177_1 SPAS-NEXRAD Analysis

General Storm Location: Vanguard, Saskatchewan, Canada

Storm Dates: July 3-4, 2000 (7/3/2000 1600 UTC – 7/4/2000 0900 UTC)

Event: MCC

DAD Zone 1:

Latitude: 49.9218°

Longitude: -107.2100°

Max. Grid Rainfall Amount: 388mm

Max. Observed Rainfall Amount: 375mm

Number of Stations: 73 (1 Daily, 1 Hourly, 0 Hourly Estimated, 13 Hourly Pseudo, 53 Supplemental, and 5 Supplemental Estimated)

SPAS Version: 8.5

Base Map Used: A blend of an isohyetal from a technical report, the Level III radar-estimated precipitation from the Glasgow, MT radar and the ippt results.

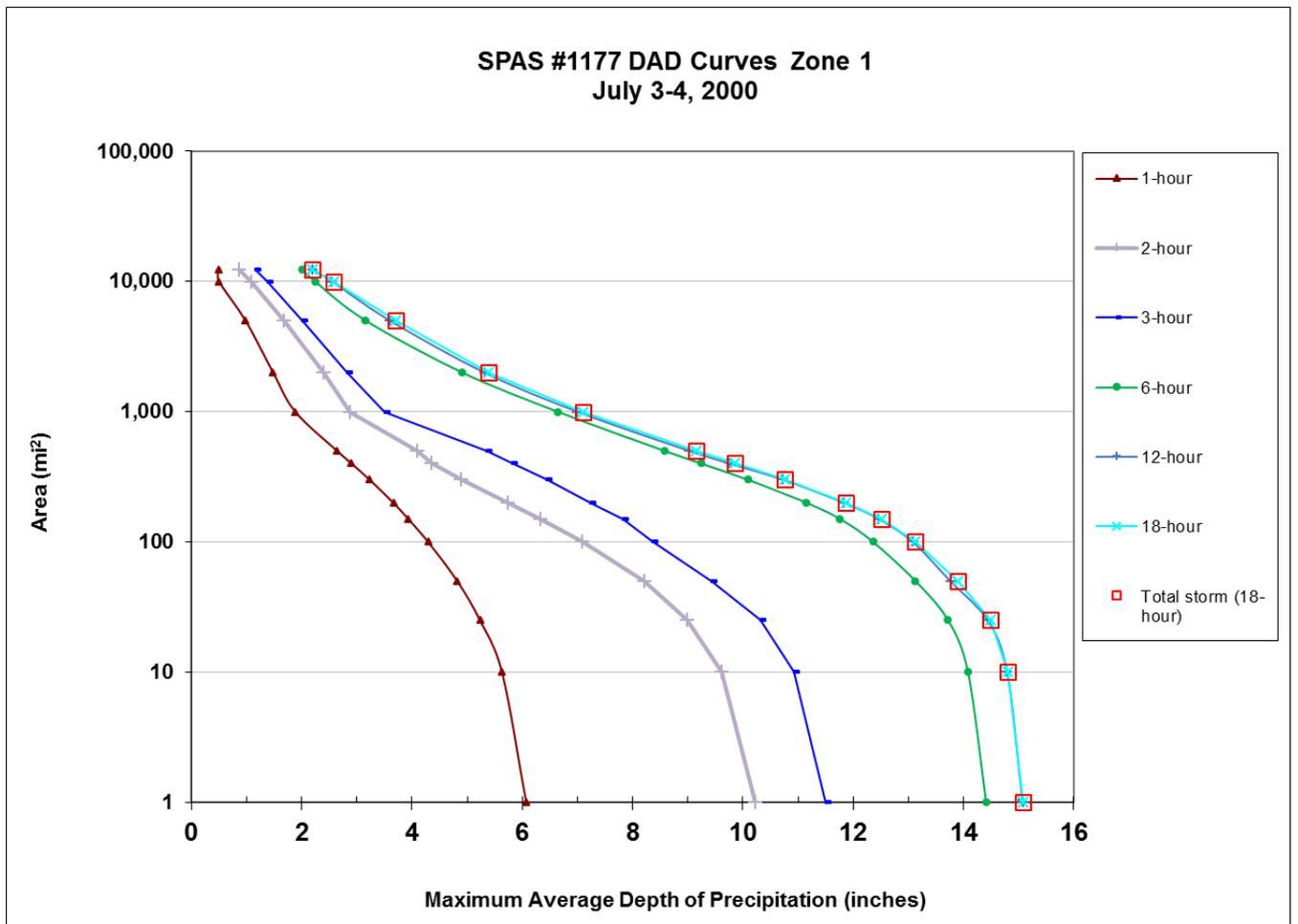
Spatial resolution: 36 seconds (degree: minute: second, WGS84, ~ 0.31 mi², 0.80 km²)

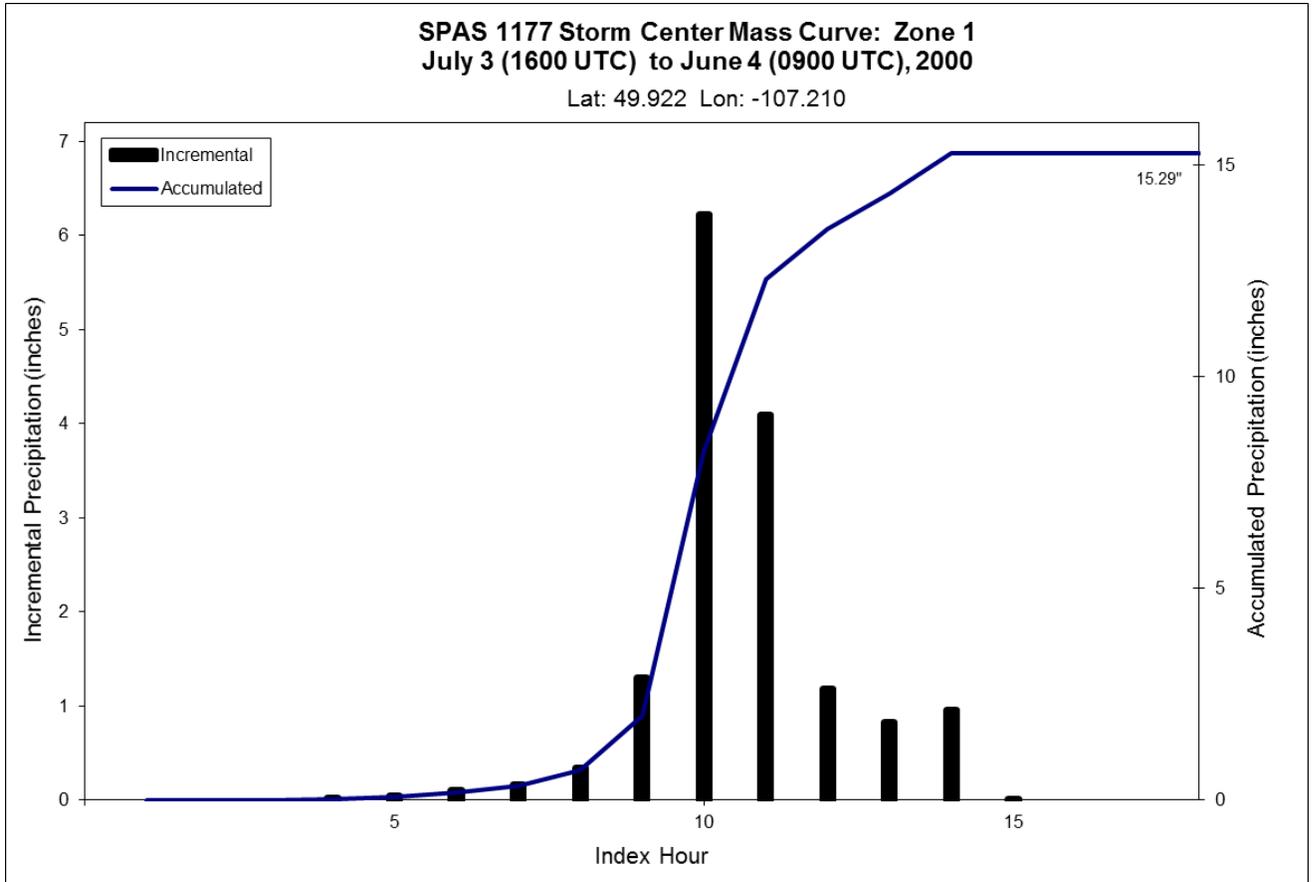
Radar Included: Yes (KGGW)

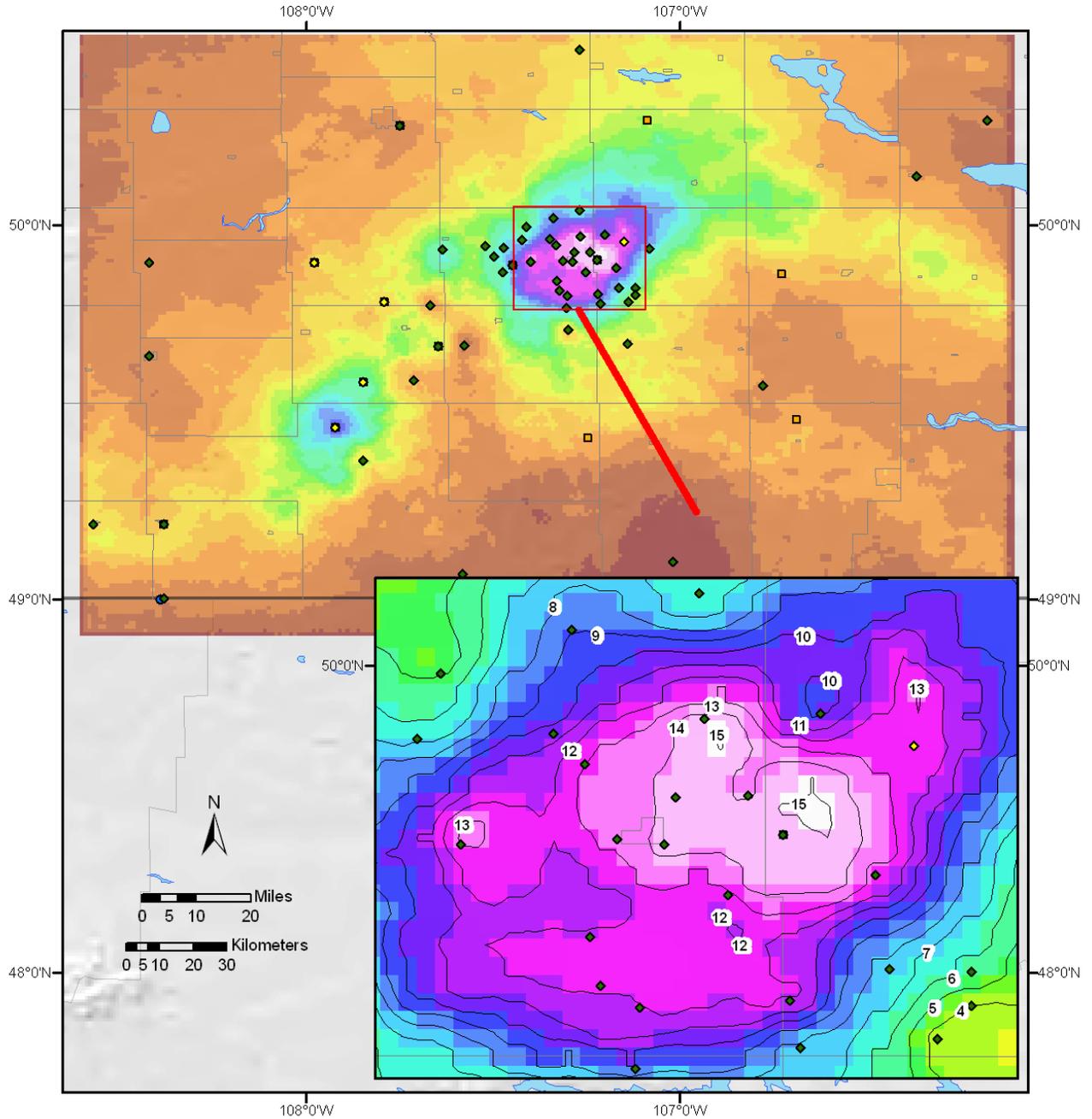
Depth-Area-Duration (DAD) analysis: Yes

Reliability of results: Given the bucket survey in/around the Vanguard storm center, we have a relatively high degree of confidence in the magnitude of precipitation in/around Vanguard; elsewhere we have less confidence. Although this storm had radar data, the storm cells occurred at the outer limits of the radar scan. Level II radar data was only available for the first half of the storm, while coarser Level III data was available for the latter half of the storm. We have moderate confidence in the overall spatial patterns of the storm precipitation. The temporal distribution of precipitation was largely governed by pseudo hourly gauges derived from a default ZR relationship and the radar data. Anecdotal information from the bucket survey however provided some good guidance on rainfall intensities, which the final results are consistent with.

Storm 1177 - July 3 (1600 UTC) - July 4 (900 UTC), 2000							
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)							
Area (mi ²)	Duration (hours)						
	1	2	3	6	12	18	Total
0.3	6.25	10.37	11.62	14.58	15.29	15.29	15.29
1	6.07	10.22	11.5	14.41	15.07	15.07	15.07
10	5.63	9.61	10.92	14.08	14.79	14.81	14.81
25	5.23	8.99	10.32	13.72	14.44	14.48	14.48
50	4.82	8.21	9.42	13.13	13.76	13.9	13.90
100	4.29	7.09	8.35	12.36	13.08	13.12	13.12
150	3.93	6.32	7.83	11.76	12.46	12.51	12.51
200	3.66	5.74	7.24	11.15	11.83	11.87	11.87
300	3.23	4.89	6.43	10.09	10.73	10.75	10.75
400	2.9	4.36	5.81	9.24	9.76	9.86	9.86
500	2.64	4.1	5.34	8.58	9.03	9.15	9.15
1,000	1.88	2.87	3.51	6.64	7	7.11	7.11
2,000	1.48	2.4	2.82	4.91	5.31	5.39	5.39
5,000	0.98	1.67	2.01	3.16	3.6	3.71	3.71
10,000	0.5	1.08	1.38	2.24	2.55	2.58	2.58
12,353	0.49	0.86	1.16	2	2.2	2.2	2.20



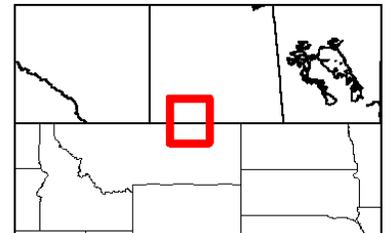




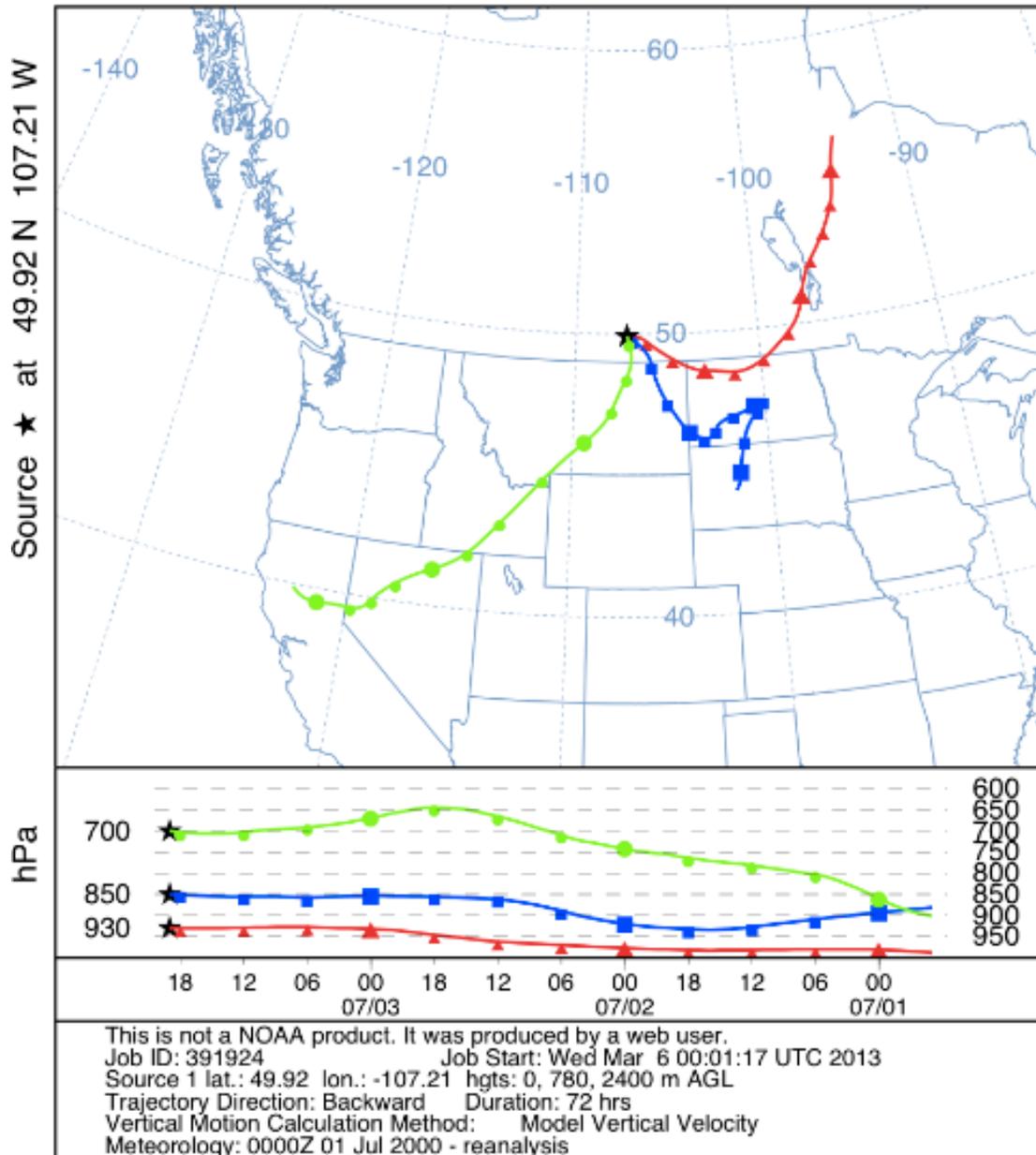
Vanguard, Saskatchewan Storm of July 3, 2000
Total 18-hour Precipitation in Inches
7/3/2000 1600 UTC – 7/4/2000 0900 UTC
SPAS #1177

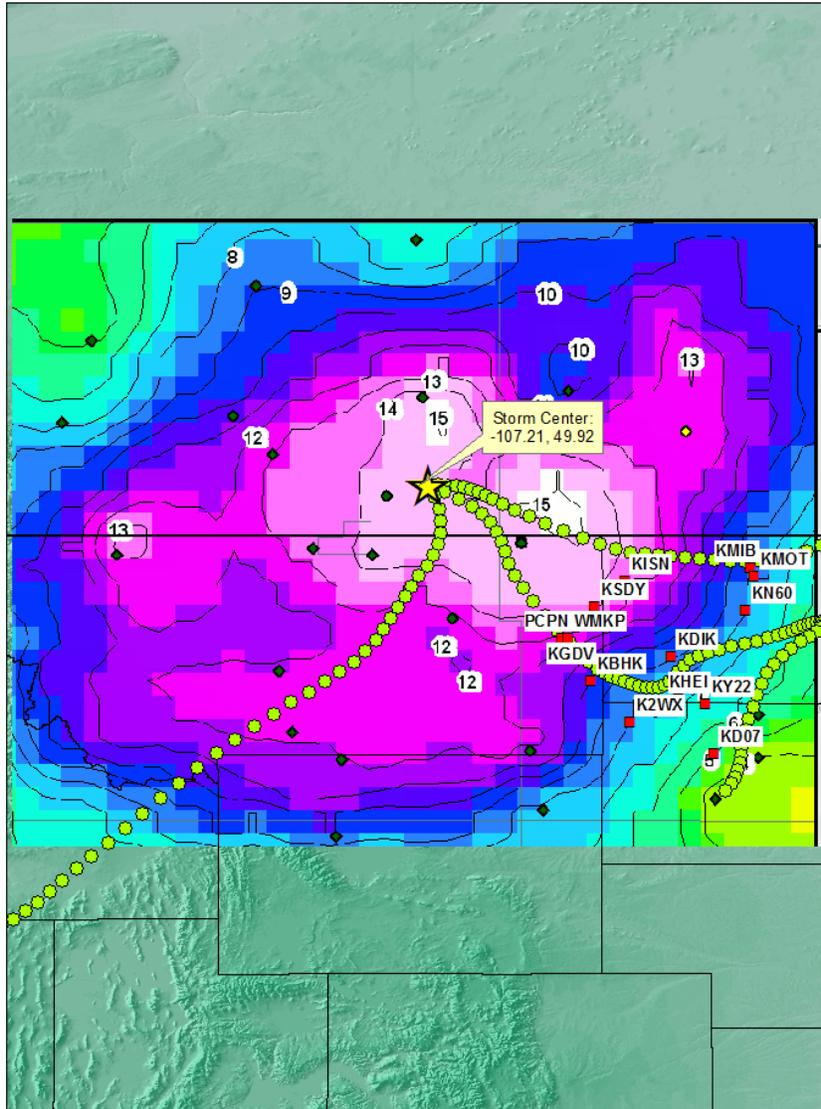
Precipitation (inches)

- | | | | | |
|---------------|---------------|-----------------|-----------------|---------------------|
| ■ 0.28 - 0.50 | ■ 3.01 - 3.50 | ■ 7.01 - 8.00 | ■ 13.01 - 14.00 | ● Daily |
| ■ 0.51 - 1.00 | ■ 3.51 - 4.00 | ■ 8.01 - 9.00 | ■ 14.01 - 15.00 | ■ Hourly |
| ■ 1.01 - 1.50 | ■ 4.01 - 4.50 | ■ 9.01 - 10.00 | □ 15.01 - 16.00 | ■ Hourly Pseudo |
| ■ 1.51 - 2.00 | ■ 4.51 - 5.00 | ■ 10.01 - 11.00 | | ◆ Supplemental |
| ■ 2.01 - 2.50 | ■ 5.01 - 6.00 | ■ 11.01 - 12.00 | | ◆ Supplemental Est. |
| ■ 2.51 - 3.00 | ■ 6.01 - 7.00 | ■ 12.01 - 13.00 | | |



NOAA HYSPLIT MODEL
 Backward trajectories ending at 1900 UTC 03 Jul 00
 CDC1 Meteorological Data





Storm Precipitation Analysis System (SPAS) For Storm #1726_1 SPAS-NEXRAD Analysis

General Storm Location: Upper Turtle River Watershed

Storm Dates: October 11-13, 2000

Event: Local

DAD Zone 1

Latitude: 47.9550

Longitude: -97.7550

Max. Grid Rainfall Amount: 20.00"

Max. Observed Rainfall Amount: 20.00"

Number of Stations: 254

Basemap: defaultP_285

Spatial resolution: 0.3189

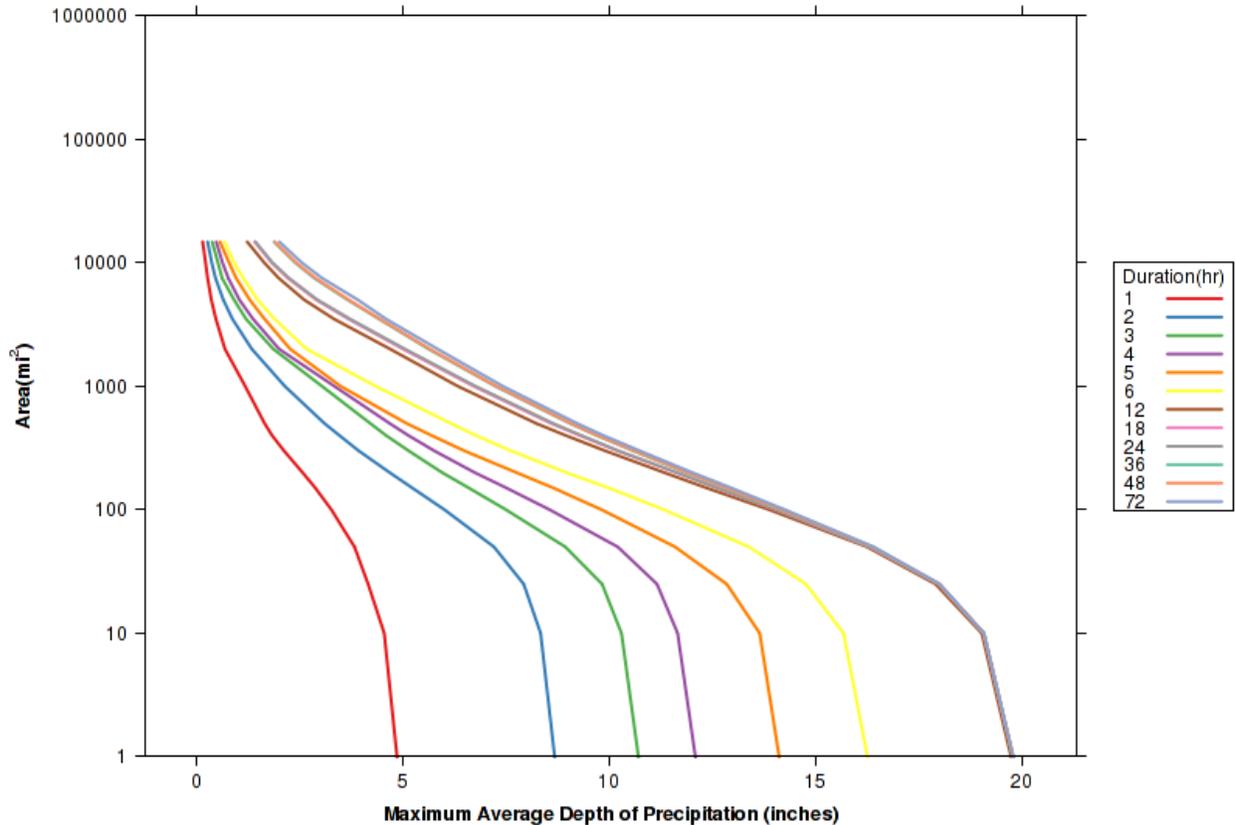
Radar Included: Yes

Depth-Area-Duration (DAD) analysis: Yes

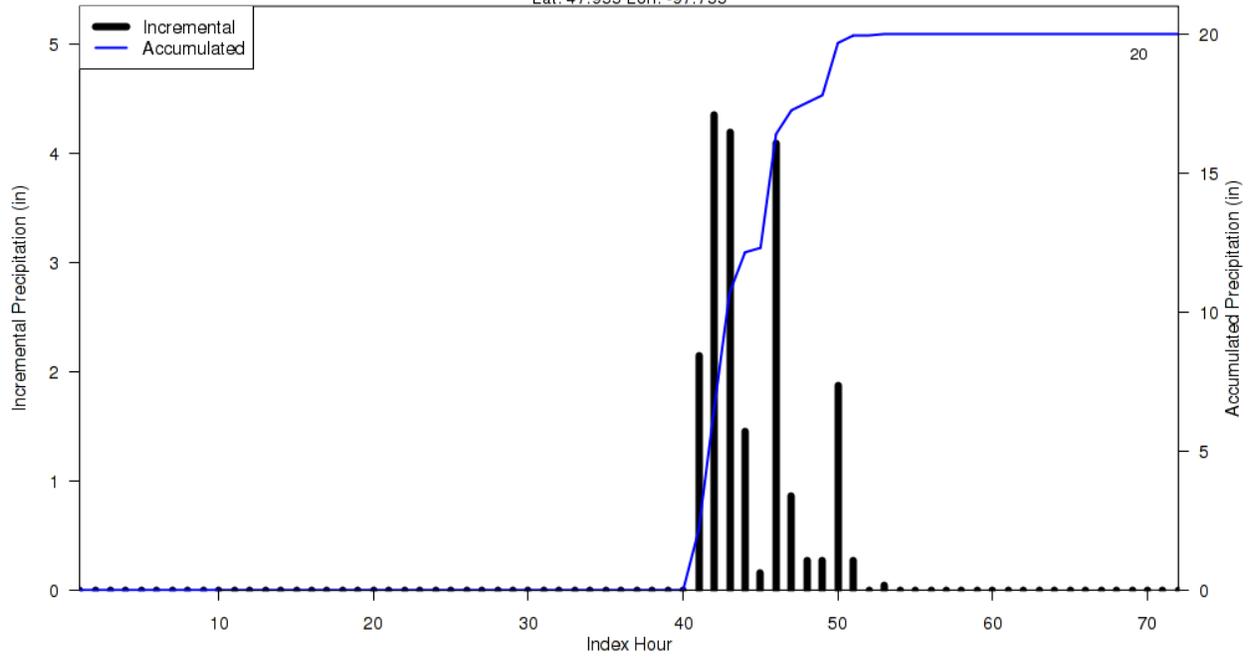
Reliability of results: This analysis was based on 254 hourly stations, daily data, supplemental station data and NEXRAD Radar. We have a good degree of confidence for the radar/station based storm total results. The spatial pattern is dependent on the radar data and basemap. Timing is based on the hourly and hourly pseudo stations. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

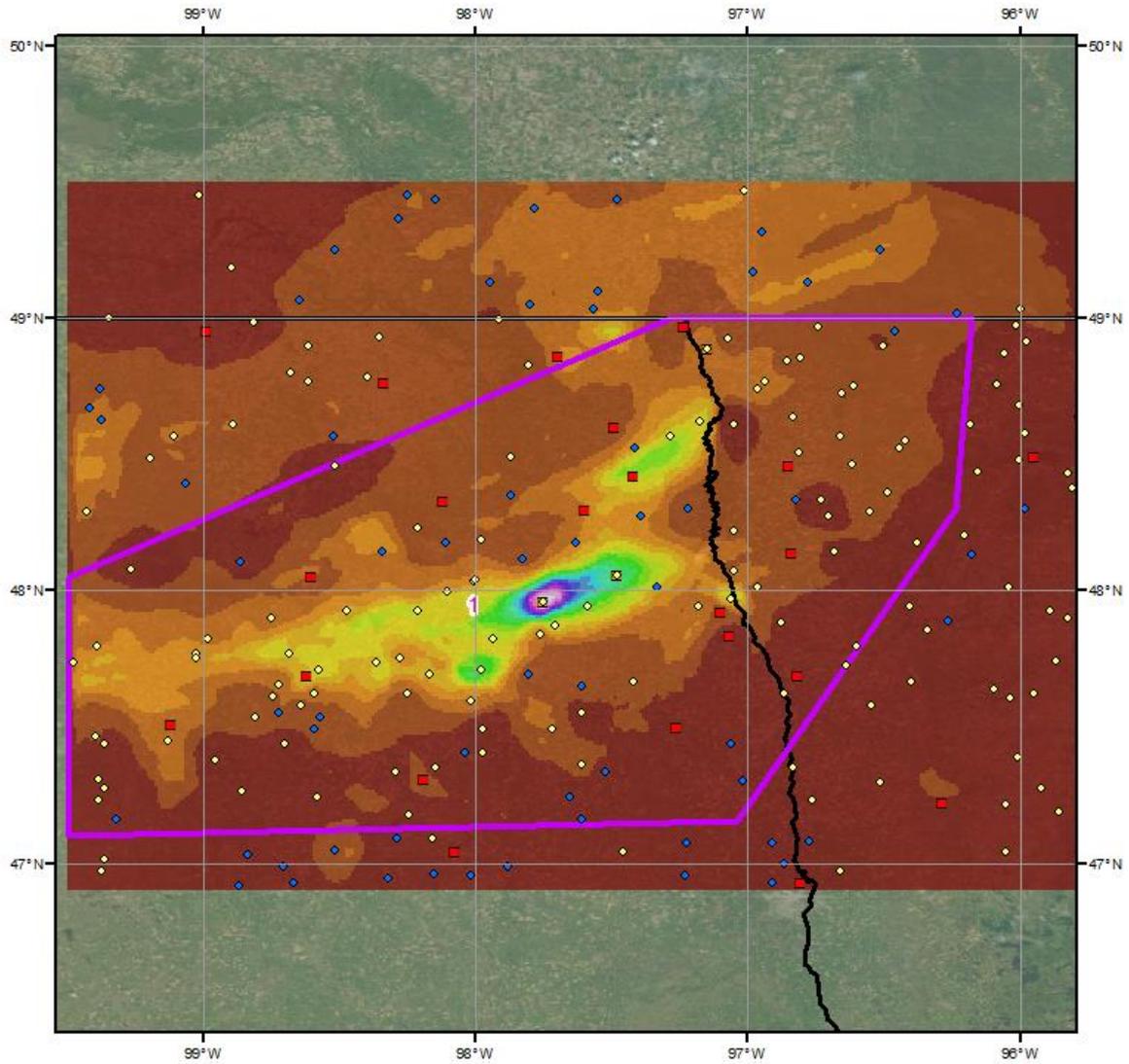
Storm 1726 - June 11 (0700 UTC) - June 14 (0600 UTC), 2000													
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)													
Area (mi ²)	Duration (hours)												
	1	2	3	4	5	6	12	18	24	36	48	72	Total
0.4	4.91	8.77	10.81	12.18	14.24	16.39	19.91	19.96	19.96	19.96	19.96	19.96	19.96
1	4.86	8.68	10.71	12.09	14.12	16.26	19.74	19.79	19.79	19.79	19.79	19.79	19.79
10	4.55	8.34	10.30	11.66	13.65	15.68	19.03	19.08	19.08	19.08	19.08	19.08	19.08
25	4.16	7.93	9.83	11.16	12.85	14.77	17.91	17.99	17.99	18.00	18.00	18.01	18.01
50	3.83	7.21	8.94	10.21	11.60	13.39	16.25	16.32	16.32	16.38	16.38	16.41	16.41
100	3.27	6.01	7.50	8.56	9.82	11.33	13.88	14.05	14.06	14.17	14.18	14.26	14.26
200	2.57	4.68	5.95	6.74	7.75	8.96	11.33	11.62	11.64	11.87	11.89	12.01	12.01
300	2.12	3.93	5.14	5.76	6.49	7.62	9.90	10.20	10.22	10.58	10.61	10.74	10.74
400	1.83	3.46	4.59	5.13	5.69	6.76	8.94	9.28	9.32	9.69	9.71	9.85	9.85
500	1.65	3.10	4.21	4.68	5.09	6.16	8.23	8.59	8.64	9.05	9.07	9.22	9.22
1,000	1.18	2.14	3.04	3.34	3.49	4.34	6.33	6.71	6.76	7.24	7.26	7.42	7.42
2,000	0.69	1.34	1.86	2.00	2.27	2.67	4.69	5.00	5.05	5.62	5.65	5.84	5.84
5,000	0.36	0.65	0.91	1.04	1.29	1.48	2.61	2.90	2.93	3.66	3.69	3.91	3.91
10,000	0.22	0.37	0.52	0.63	0.79	0.91	1.64	1.82	1.84	2.39	2.41	2.55	2.55

SPAS 1726 DAD Curves Zone 1
June 11 (0700UTC) to June 14 (0600UTC), 2000



SPAS 1726 Storm Center Mass Curve Zone 1
June 11 (0700UTC) to June 14 (0600UTC), 2000
Lat: 47.955 Lon: -97.755

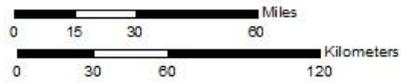




**Total Storm (72-hours) Precipitation (inches)
 June 11 (0700 UTC) - June 14 (0600 UTC), 2000
 SPAS-NEXRAD 1726**

Gauges

- ◆ Daily
- Hourly
- Hourly Pseudo
- ◇ Supplemental
- ◆ SE

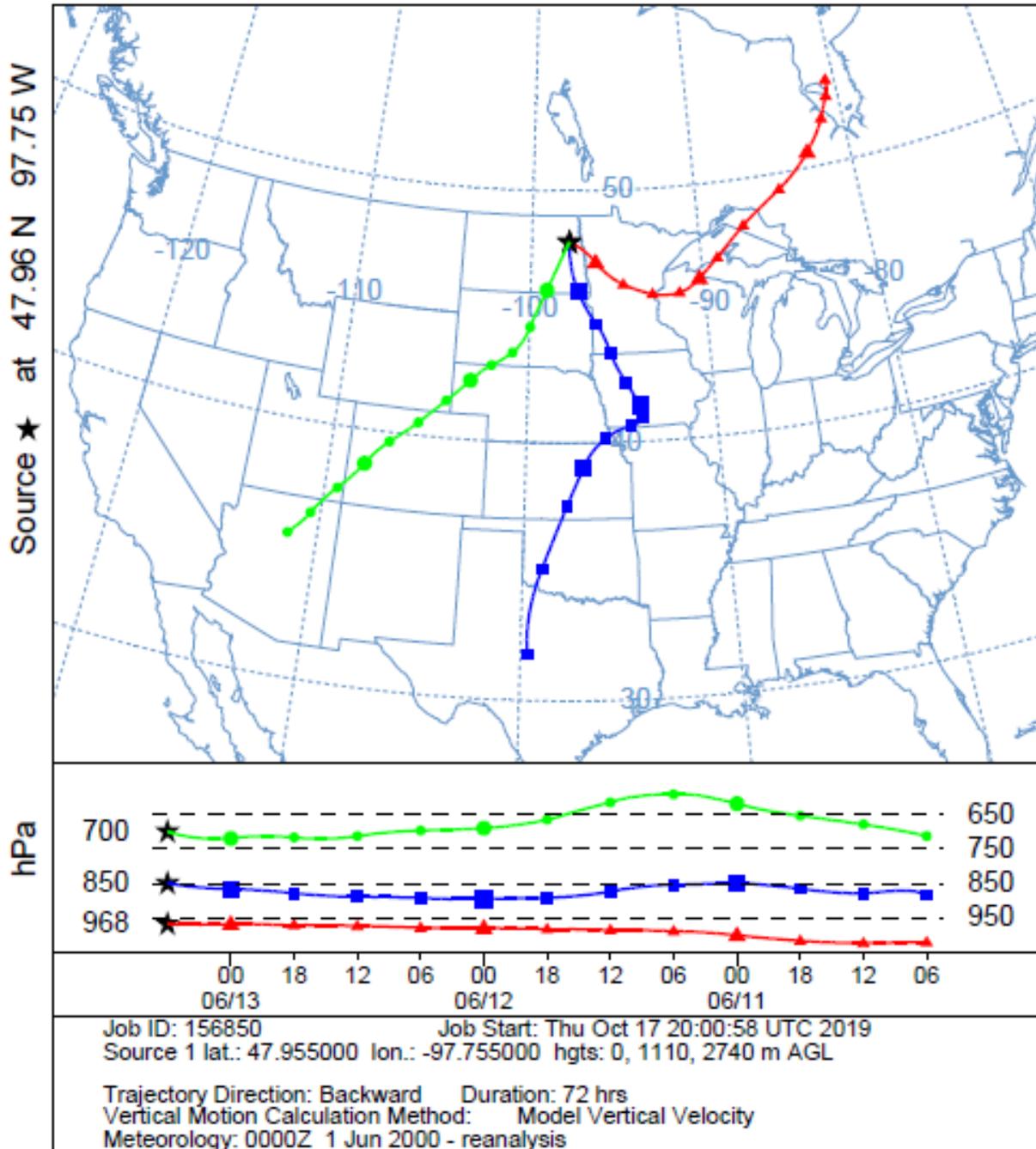


Precipitation (inches)

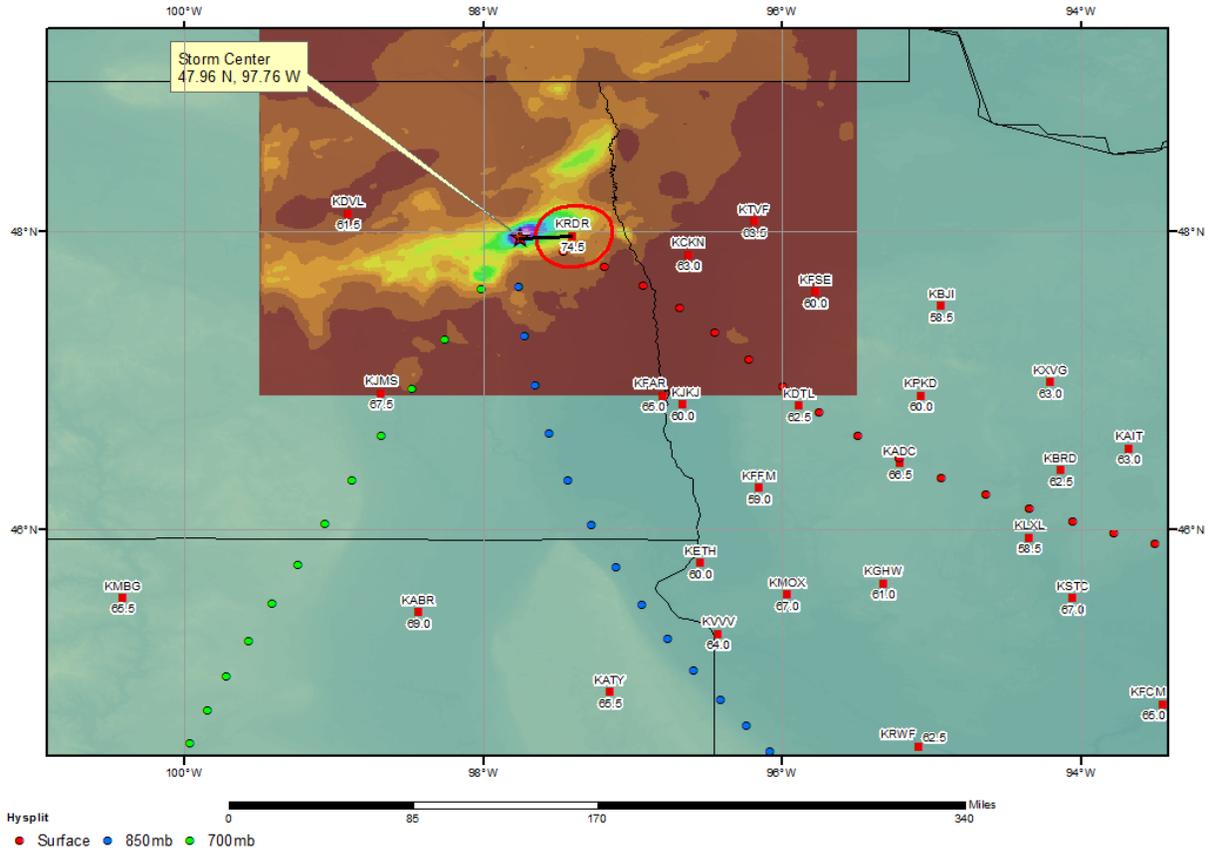
0.00 - 1.00	4.01 - 5.00	9.01 - 10.00	14.01 - 15.00
1.01 - 2.00	5.01 - 6.00	10.01 - 11.00	15.01 - 16.00
2.01 - 3.00	6.01 - 7.00	11.01 - 12.00	16.01 - 17.00
3.01 - 4.00	7.01 - 8.00	12.01 - 13.00	17.01 - 18.00
	8.01 - 9.00	13.01 - 14.00	18.01 - 19.00
			19.01 - 20.00



NOAA HYSPLIT MODEL
 Backward trajectories ending at 0600 UTC 13 Jun 00
 CDC1 Meteorological Data



SPAS 1726 Storm Analysis June 12-13, 2000



Storm Precipitation Analysis System (SPAS) For Storm #1033_1 SPAS-NEXRAD Analysis

General Storm Location: Ogallala, NE

Storm Dates: July 6 (300Z, 2100 MDT) – 7 (600Z, 0000 MDT), 2002

Event: Convective Thunderstorm

DAD Zone 1

Latitude: 41.03

Longitude: -101.78

Rainfall Amount: 14.92" (Grid/Pixel Point)

Number of Stations: 80 (19-hourly, 3-hourly pseudo, 56-daily, and 2-supplemental) gauging stations within the define search domain. 35 (7-hourly, 2-hourly pseudo, 24-daily, and 2-supplemental) stations within radar domain.

SPAS Version: 2.0

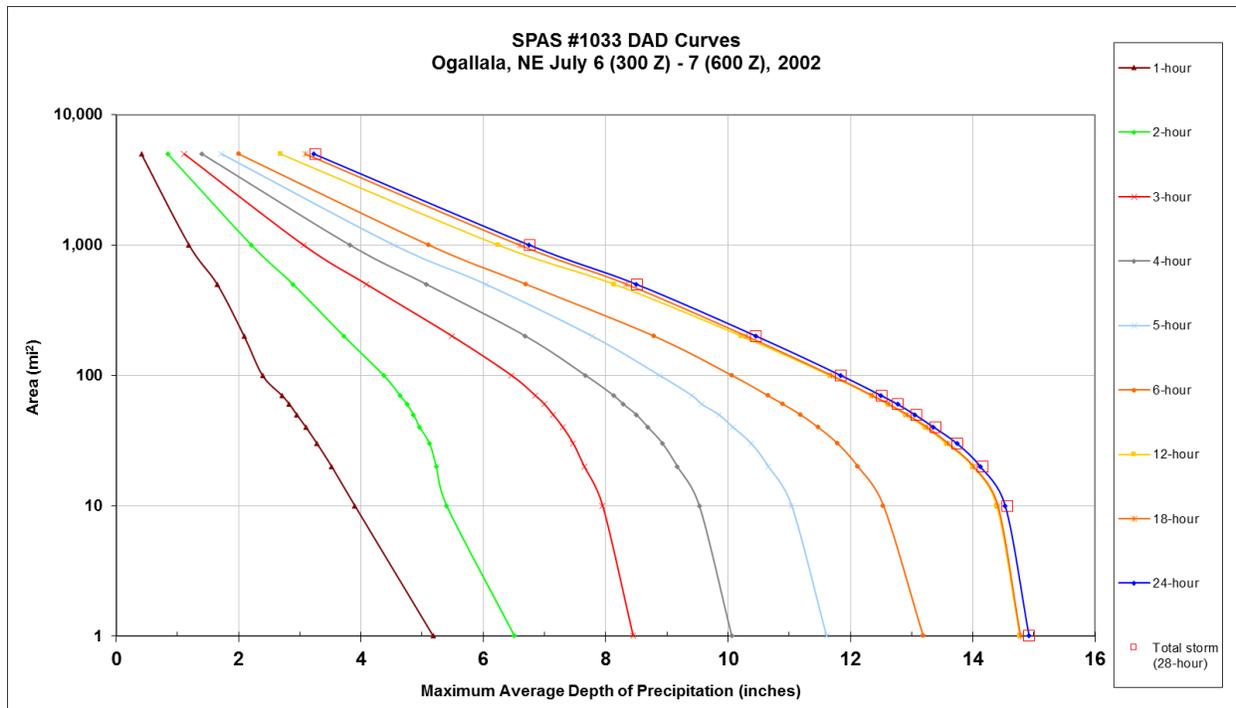
Base Map Used: No

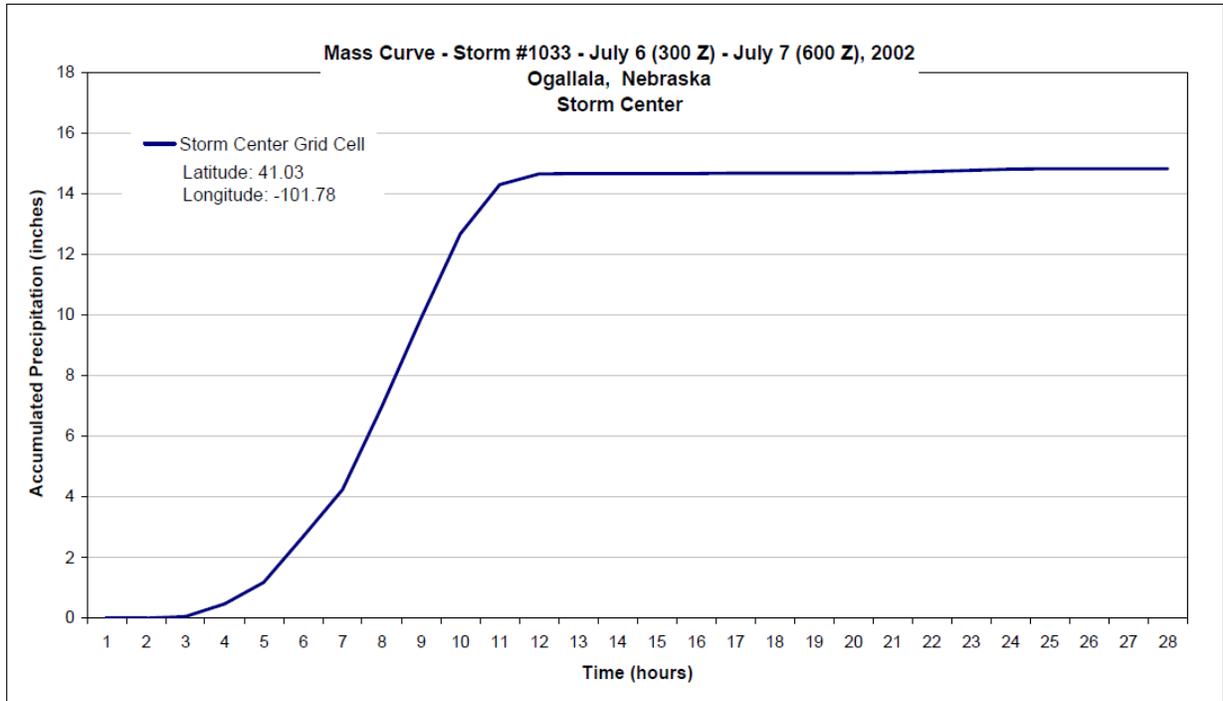
Radar Included: Yes

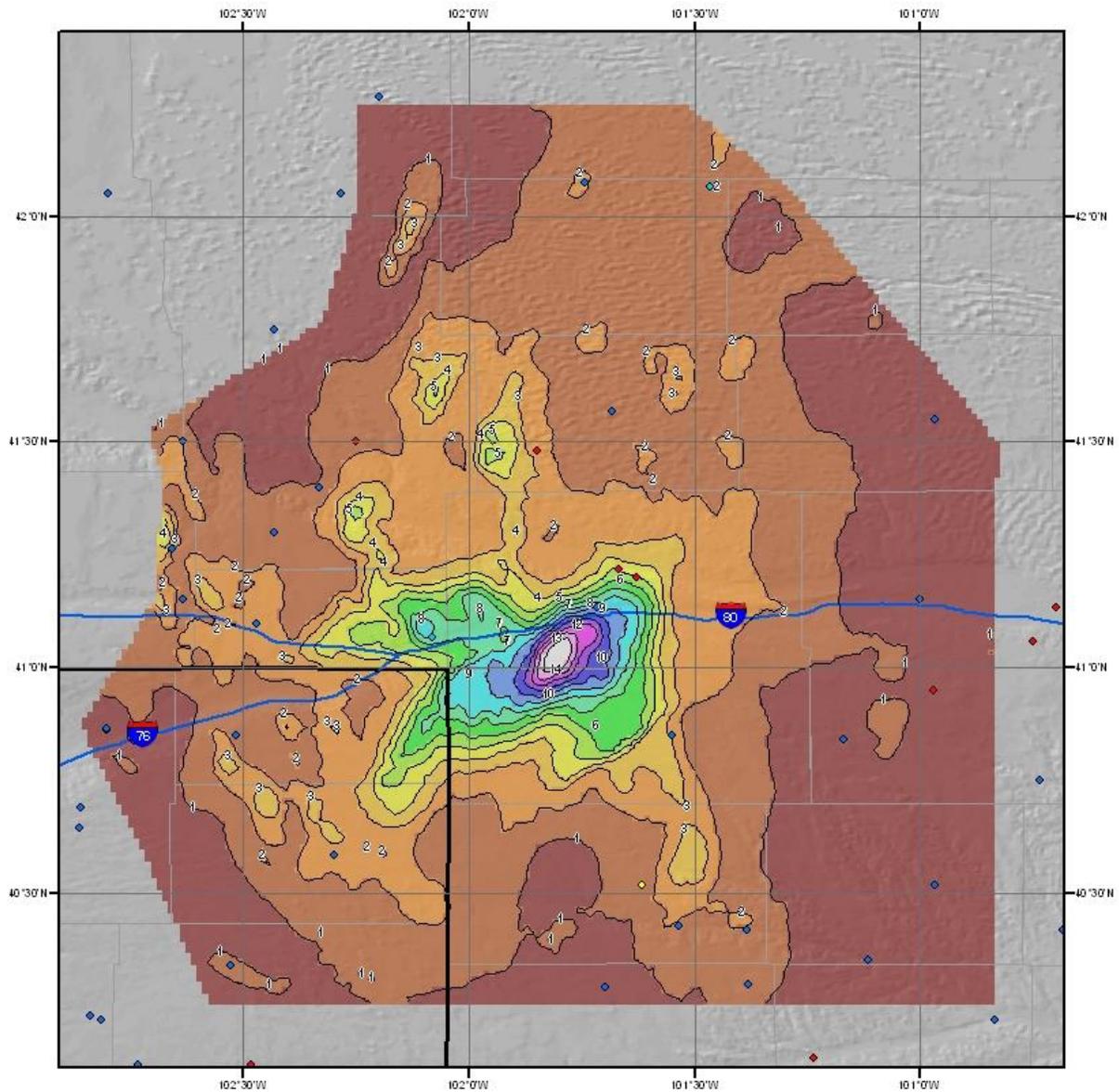
Depth-Area-Duration (DAD) analysis: Yes, 1, 2, 3, 4, 5, 6, 12, 18, 24, and 28 hours.

Storm 1033 - Ogallala, NE July 6 (300 Z) - July 7 (600 Z), 2002
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)

Area (mi ²)	Duration (hours)										
	1	2	3	4	5	6	12	18	24	28	total
1	5.18	6.51	8.45	10.06	11.61	13.19	14.77	14.78	14.92	14.92	14.92
10	3.90	5.40	7.95	9.53	11.04	12.54	14.39	14.41	14.53	14.57	14.57
20	3.52	5.23	7.65	9.17	10.66	12.12	14.00	14.01	14.12	14.16	14.16
30	3.28	5.12	7.47	8.93	10.38	11.79	13.57	13.60	13.74	13.74	13.74
40	3.10	4.96	7.30	8.69	10.08	11.47	13.22	13.25	13.36	13.39	13.39
50	2.95	4.86	7.14	8.50	9.85	11.18	12.90	12.93	13.05	13.08	13.08
60	2.83	4.75	7.00	8.29	9.57	10.90	12.61	12.63	12.77	12.78	12.78
70	2.71	4.64	6.85	8.13	9.41	10.65	12.34	12.36	12.50	12.51	12.51
100	2.39	4.37	6.46	7.67	8.88	10.06	11.66	11.69	11.84	11.84	11.84
200	2.09	3.72	5.49	6.69	7.78	8.79	10.22	10.30	10.46	10.46	10.46
500	1.65	2.89	4.09	5.07	6.04	6.70	8.14	8.34	8.50	8.51	8.51
1,000	1.19	2.21	3.06	3.82	4.54	5.11	6.24	6.59	6.75	6.76	6.76
5,000	0.41	0.84	1.11	1.40	1.72	2.00	2.68	3.09	3.23	3.25	3.25





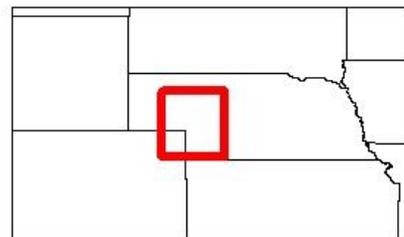
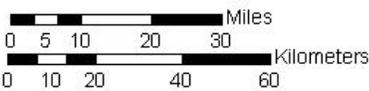


SPAS Storm #1033 - July 6 to 7, 2002
Total Rainfall (28-hours) - Ogallala, Nebraska

Precipitation (inches)



Gauging Stations

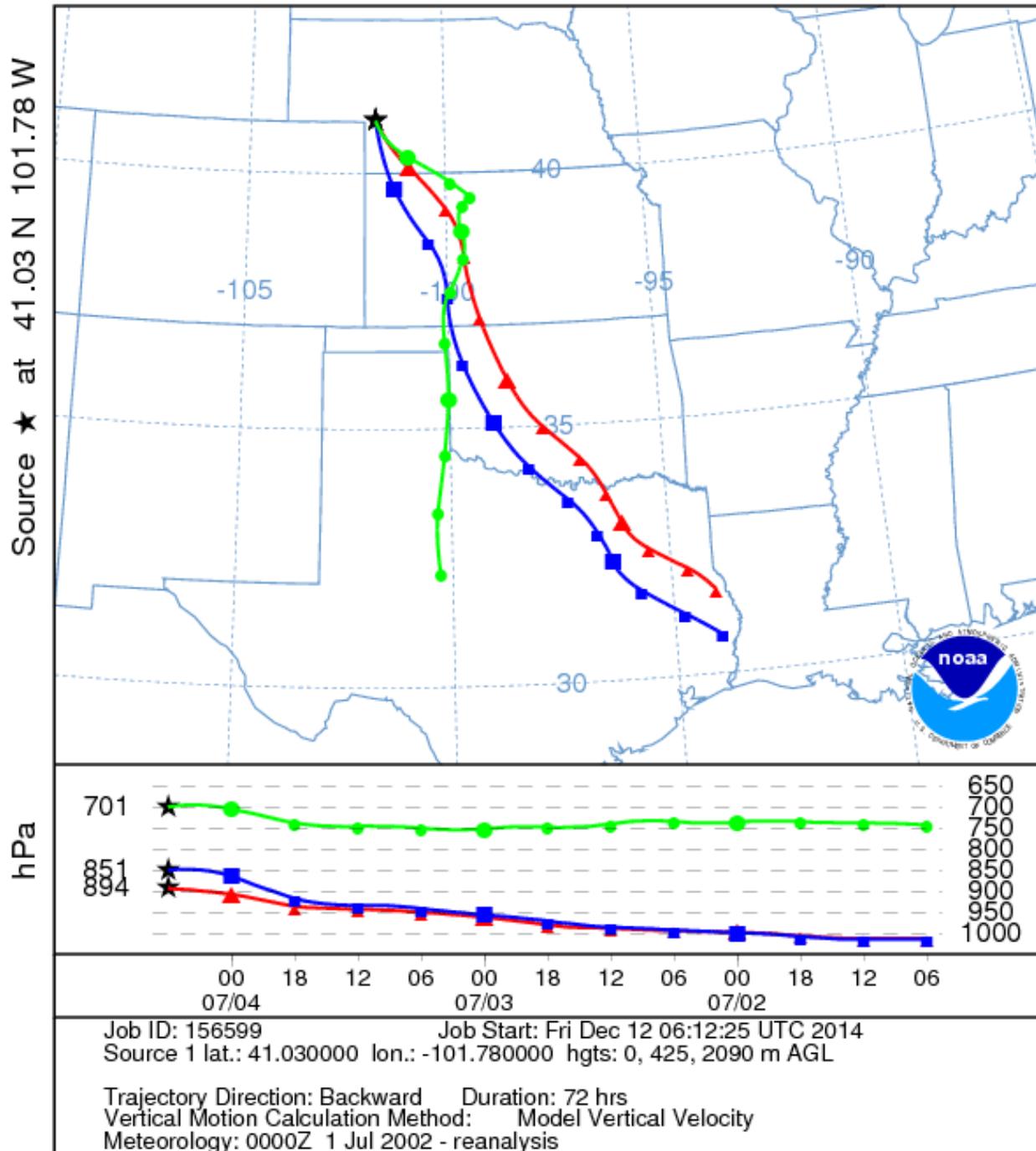


Coordinate system: GCS North American 1983
 Scale: 1:1,321,161
 NEPR #AWR April 25, 2007

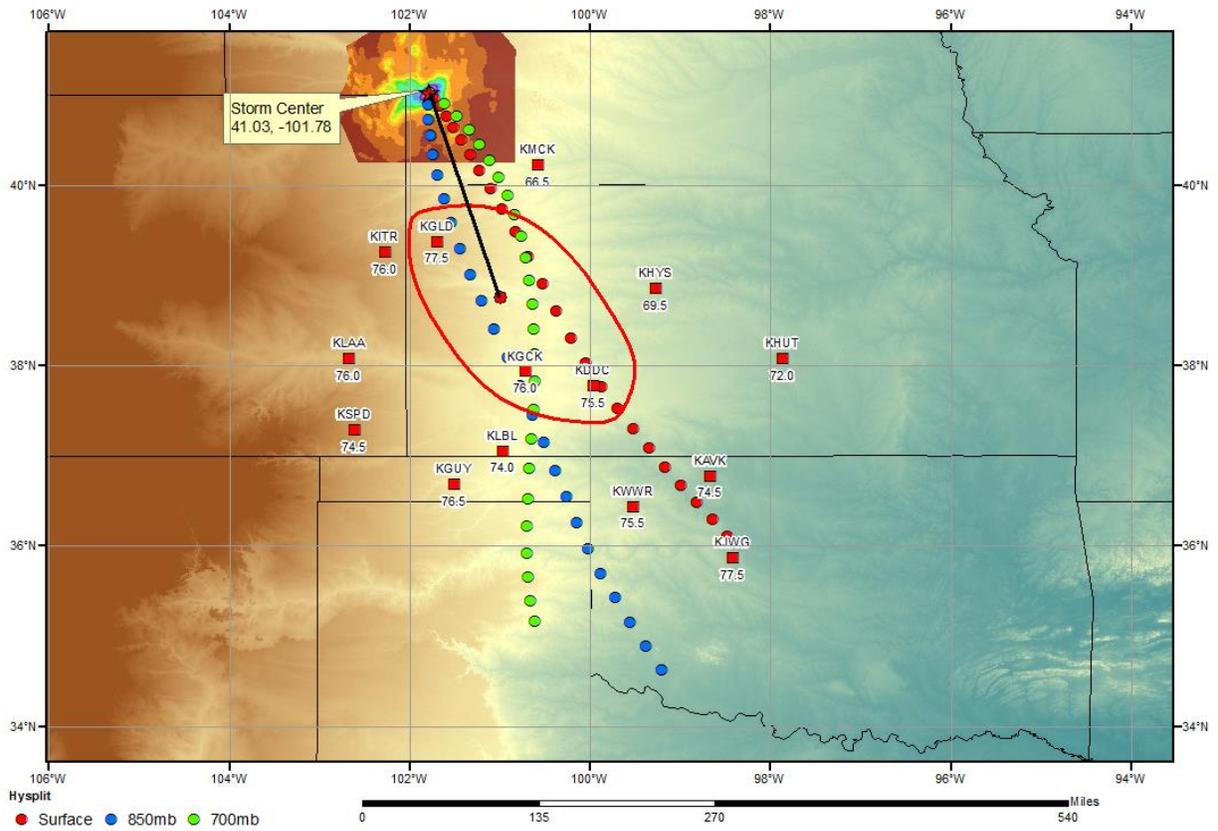
NOAA HYSPLIT MODEL

Backward trajectories ending at 0600 UTC 04 Jul 02

CDC1 Meteorological Data



SPAS 1033- Ogallala, NE Storm Analysis July 5-6, 2002



Storm Precipitation Analysis System (SPAS) For Storm #1220_1 SPAS-NEXRAD Analysis

General Storm Location: Eastern Iowa, Southwestern Wisconsin and Northwestern Illinois

Storm Dates: July 27, 2011 2100 UTC - July 28, 2011 2000 UTC

Event: Mesoscale Convective System (MCS) along a stalled front

DAD Zone 1

Latitude: 42.44

Longitude: -90.75

Max. Grid Rainfall Amount: 15.14"

Max. Observed Rainfall Amount: 15.10" (2 miles SE of Julien, IA)

Number of Stations: 157 (25 Daily, 42 Hourly, 0 Hourly Estimated, 0 Hourly Estimated Pseudo, 14 Hourly Pseudo, 76 Supplemental, and 0 Supplemental Estimated)

SPAS Version: 9.0

Basemap: PRISM Mean (1971-2000) July precipitation

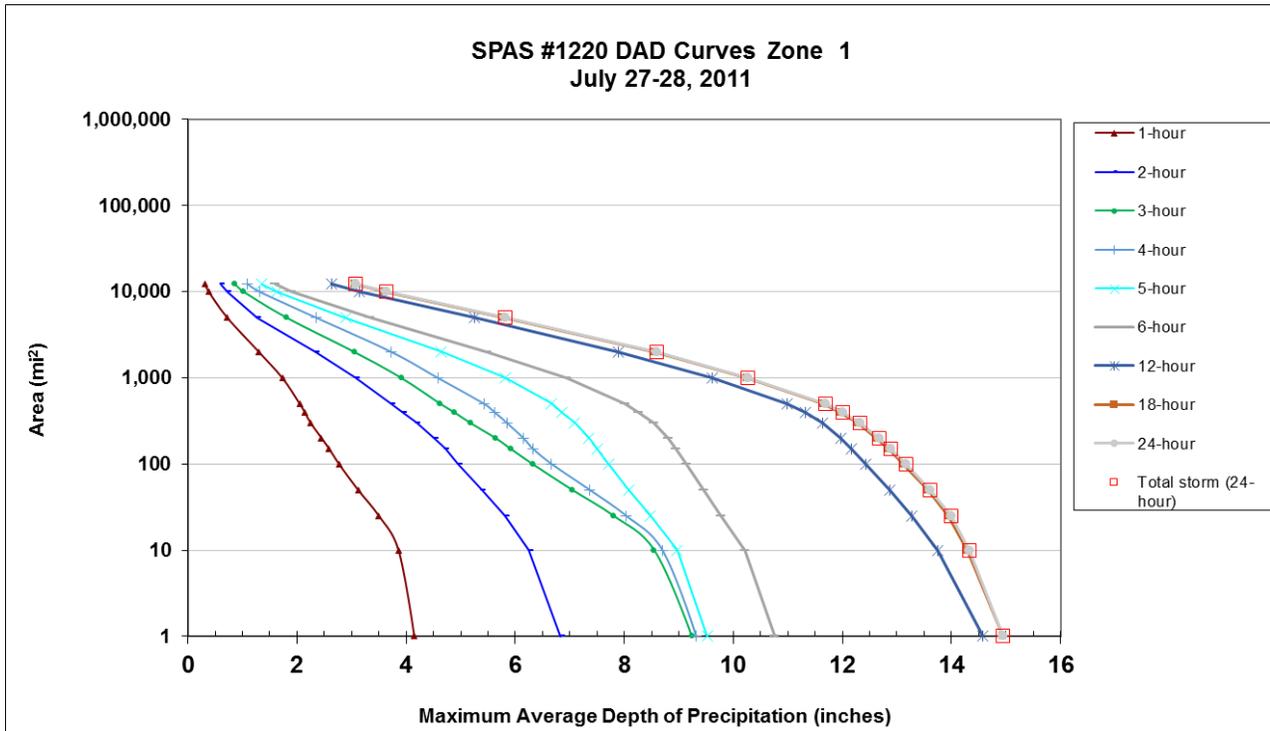
Spatial resolution: 36 seconds (~0.35 mi²)

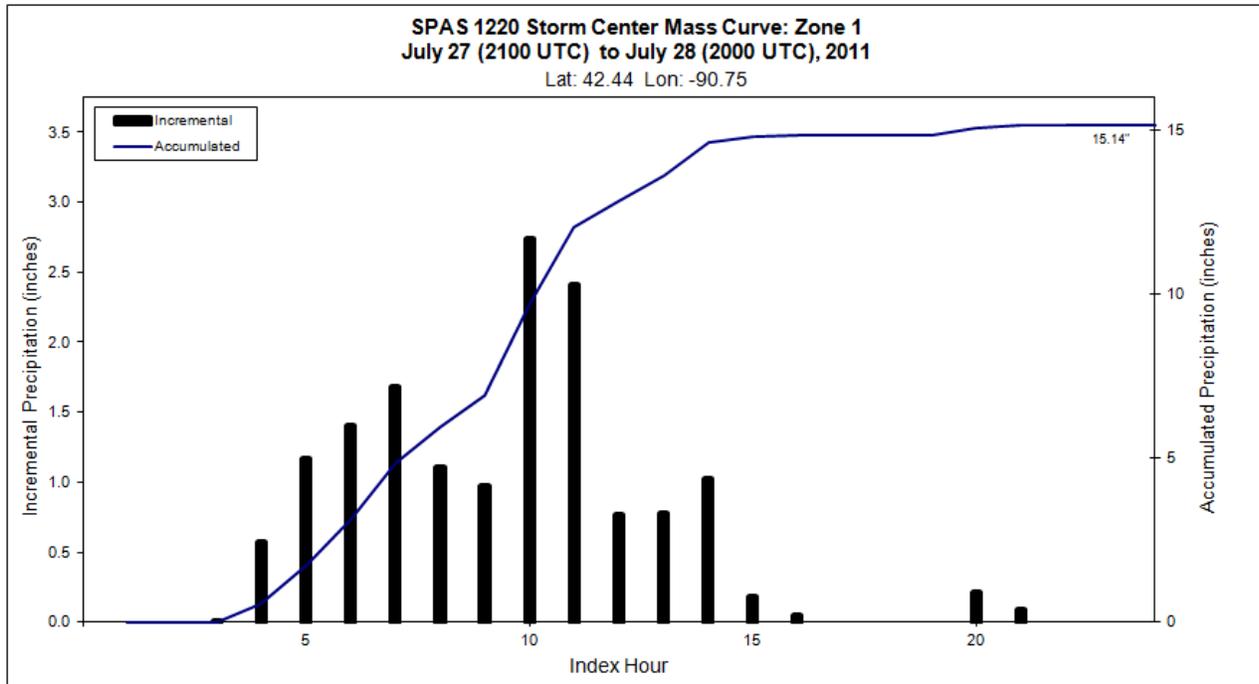
Radar Included: Yes

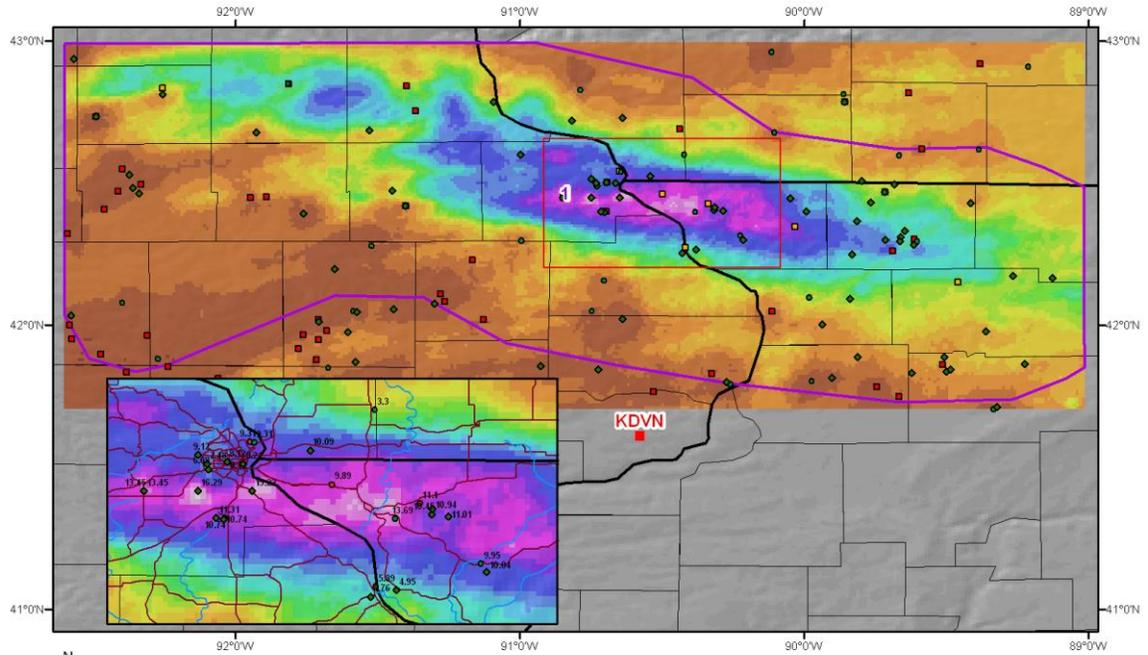
Depth-Area-Duration (DAD) analysis: Yes

Reliability of results: Given the unblocked, clean and QC'ed radar data coupled with relatively extensive gauge data, we have a very high degree of confidence in the results. No supplemental estimated stations were warranted in this analysis.

Storm 1220 - July 27 (2100 UTC) - July 28 (2000 UTC), 2011										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	2	3	4	5	6	12	18	24	Total
0.4	4.19	6.91	9.36	9.40	9.63	10.88	14.77	15.11	15.12	15.12
1	4.15	6.83	9.24	9.32	9.52	10.75	14.58	14.94	14.95	14.95
10	3.86	6.25	8.55	8.70	8.97	10.22	13.75	14.30	14.32	14.32
25	3.50	5.81	7.81	8.04	8.48	9.77	13.27	13.94	13.99	13.99
50	3.12	5.38	7.05	7.37	8.08	9.45	12.86	13.57	13.60	13.60
100	2.77	4.95	6.32	6.67	7.71	9.14	12.43	13.12	13.16	13.16
150	2.59	4.71	5.92	6.33	7.50	8.95	12.16	12.85	12.89	12.89
200	2.45	4.51	5.64	6.15	7.35	8.81	11.97	12.63	12.67	12.67
300	2.25	4.19	5.18	5.85	7.09	8.55	11.64	12.29	12.33	12.33
400	2.14	3.93	4.88	5.62	6.85	8.26	11.32	11.96	12.00	12.00
500	2.05	3.72	4.63	5.43	6.67	8.02	10.99	11.66	11.69	11.69
1,000	1.73	3.07	3.91	4.58	5.81	6.95	9.62	10.24	10.27	10.27
2,000	1.30	2.33	3.05	3.73	4.64	5.49	7.89	8.56	8.59	8.59
5,000	0.72	1.27	1.81	2.35	2.89	3.33	5.25	5.79	5.81	5.81
10,000	0.38	0.72	1.02	1.31	1.64	1.89	3.14	3.61	3.63	3.63
12,296	0.31	0.60	0.86	1.09	1.36	1.59	2.63	3.06	3.07	3.07

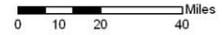
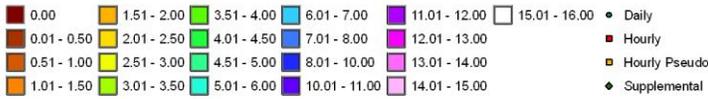






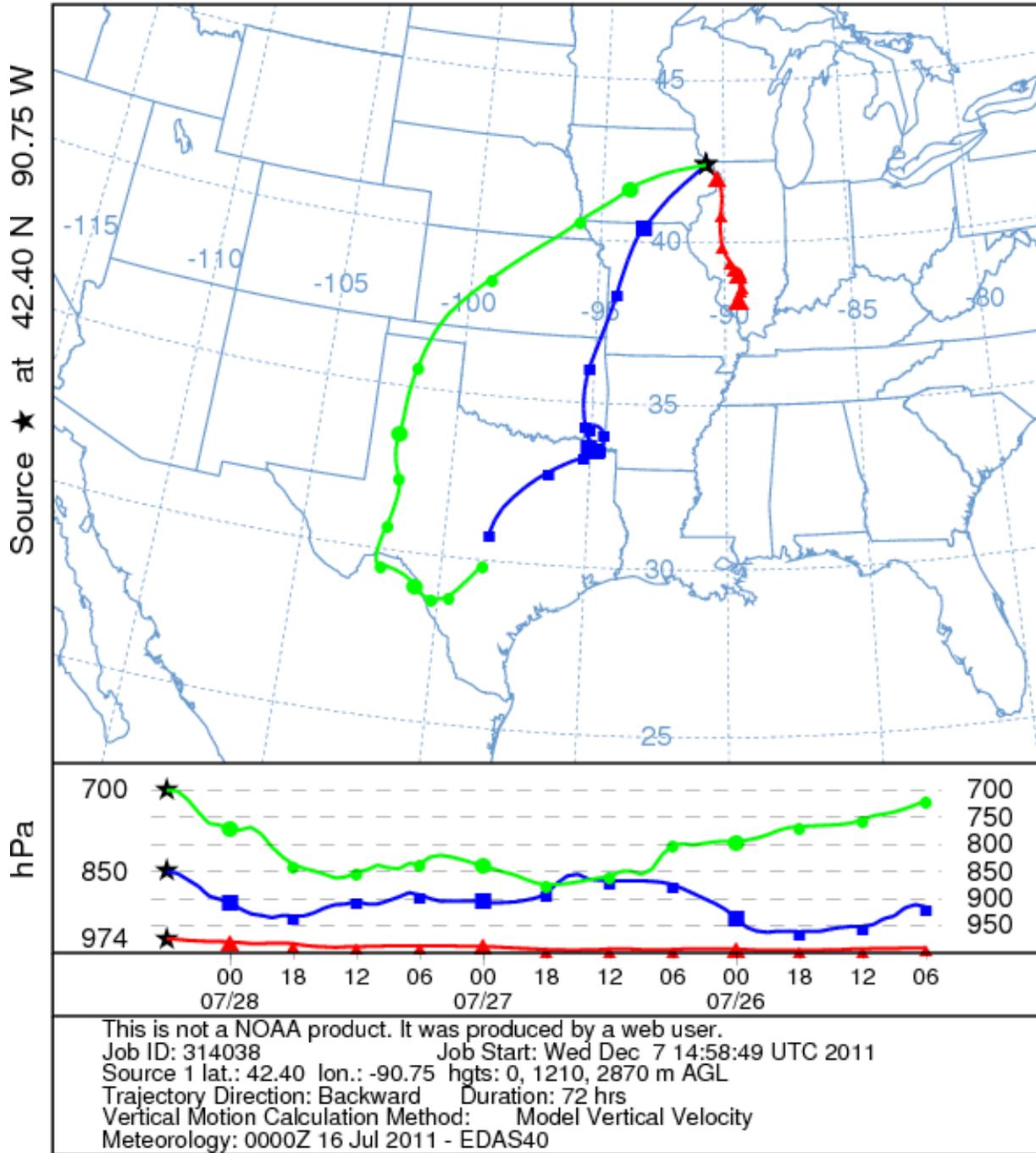
Total 24-hour Precipitation
July 27, 2011 2100 UTC - July 28, 2011 2000 UTC
SPAS #1220

Precipitation (inches)

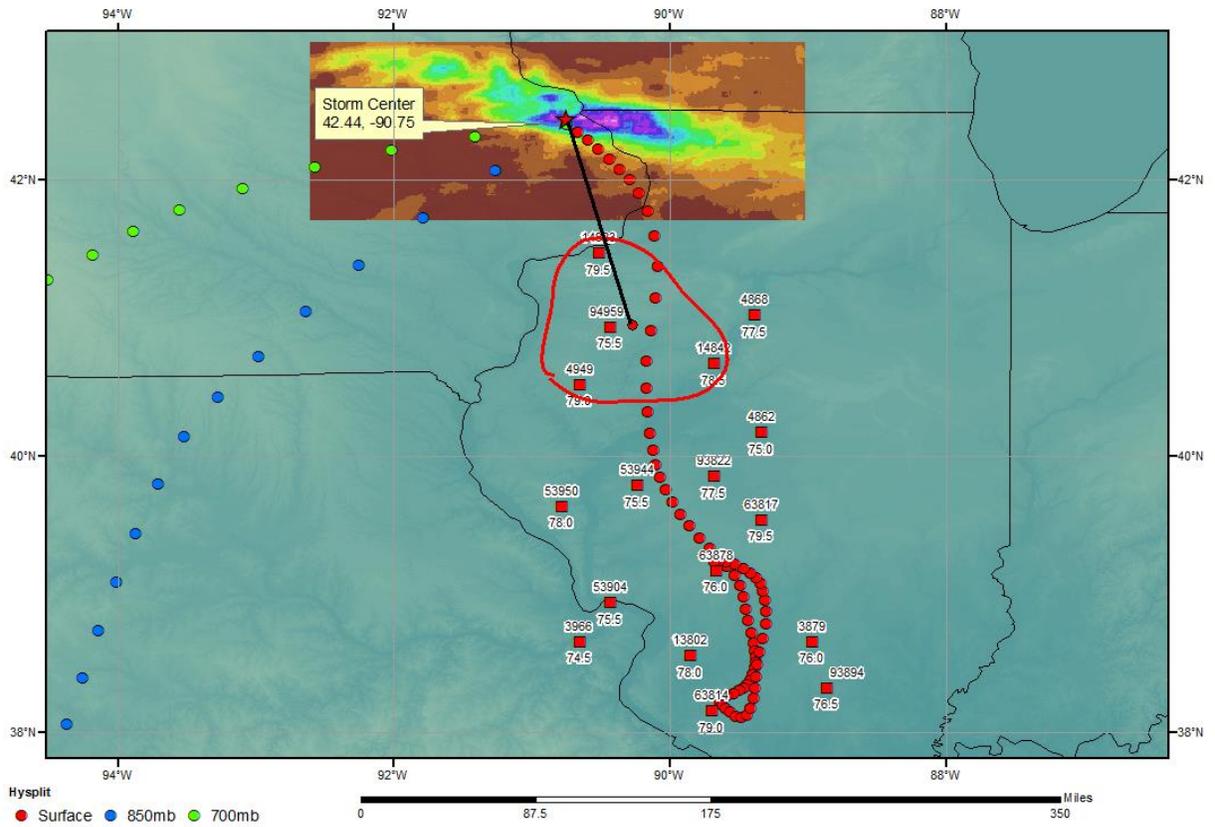


METSTAT
 12/16/2011

NOAA HYSPLIT MODEL Backward trajectories ending at 0600 UTC 28 Jul 11 EDAS Meteorological Data



SPAS 1220 - Dubuque, IA Storm Analysis July 25-28, 2011



Storm Precipitation Analysis System (SPAS) For Storm #1727_1 SPAS-NEXRAD Analysis

General Storm Location: Drummond, WI

Storm Dates: June 15-18, 2018

Event: Local

DAD Zone 1

Latitude: 46.3150

Longitude: -91.4150

Max. Grid Rainfall Amount: 17.33"

Max. Observed Rainfall Amount: 15.03"

Number of Stations: 433

Basemap: Default Radar Precipitation Total Storm (300R1.4)

Spatial resolution: 0.33

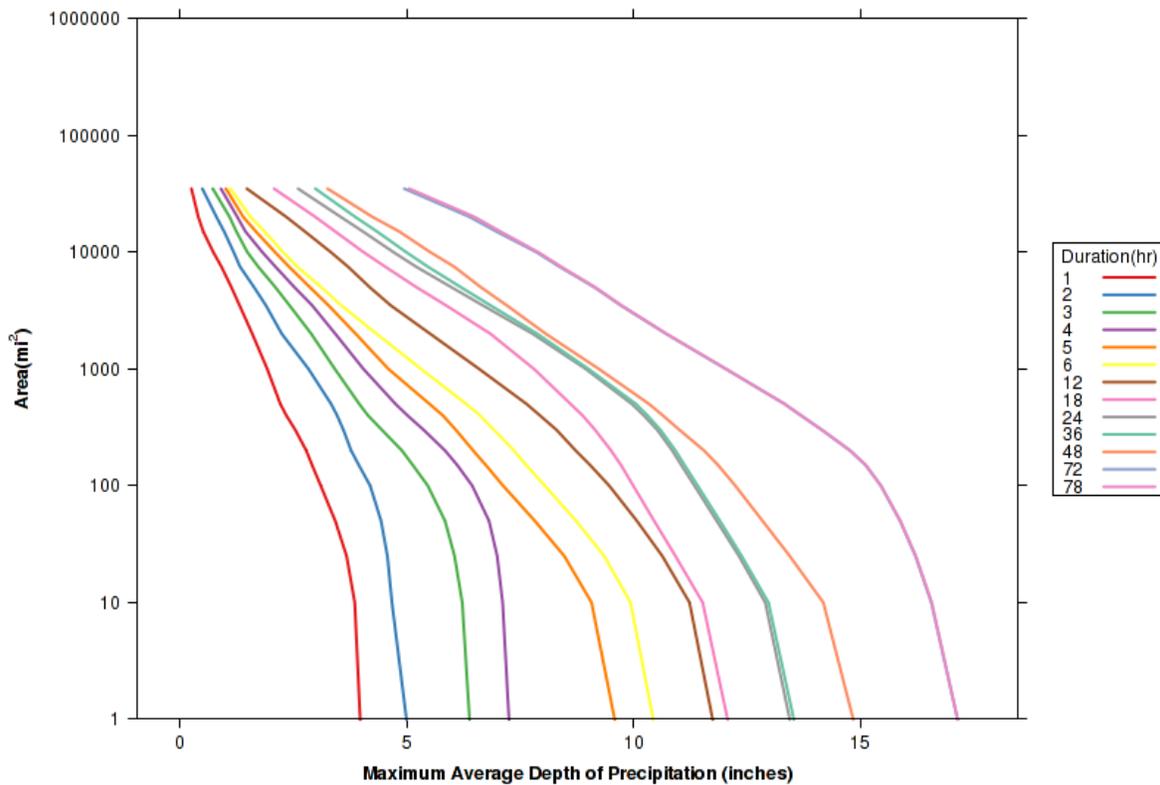
Radar Included: Yes

Depth-Area-Duration (DAD) analysis: Yes

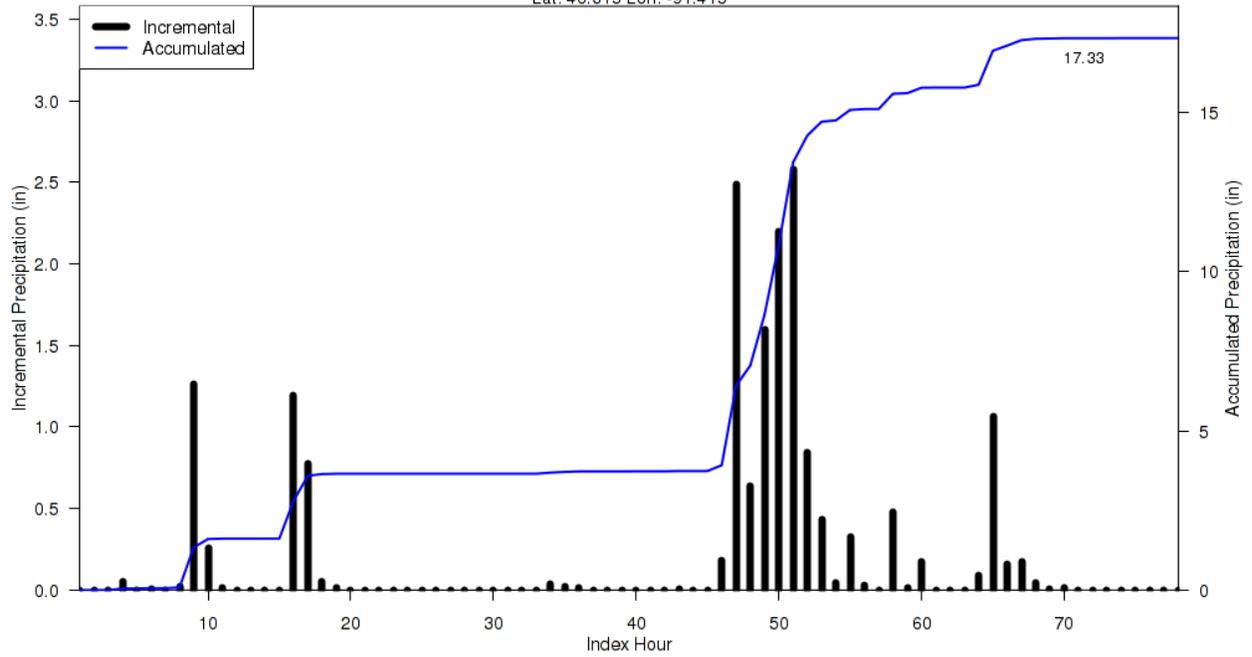
Reliability of results: This analysis was based on 433 hourly stations, daily data, supplemental station data and radar data. We have a good degree of confidence for the radar and station based storm total results. The spatial pattern is fully dependent on the radar data and basemap. Timing is based on hourly stations and sun-hourly data is based on 5-minute radar data. A couple daily stations were moved to supplemental due to timing issues and to ensure data consistency.

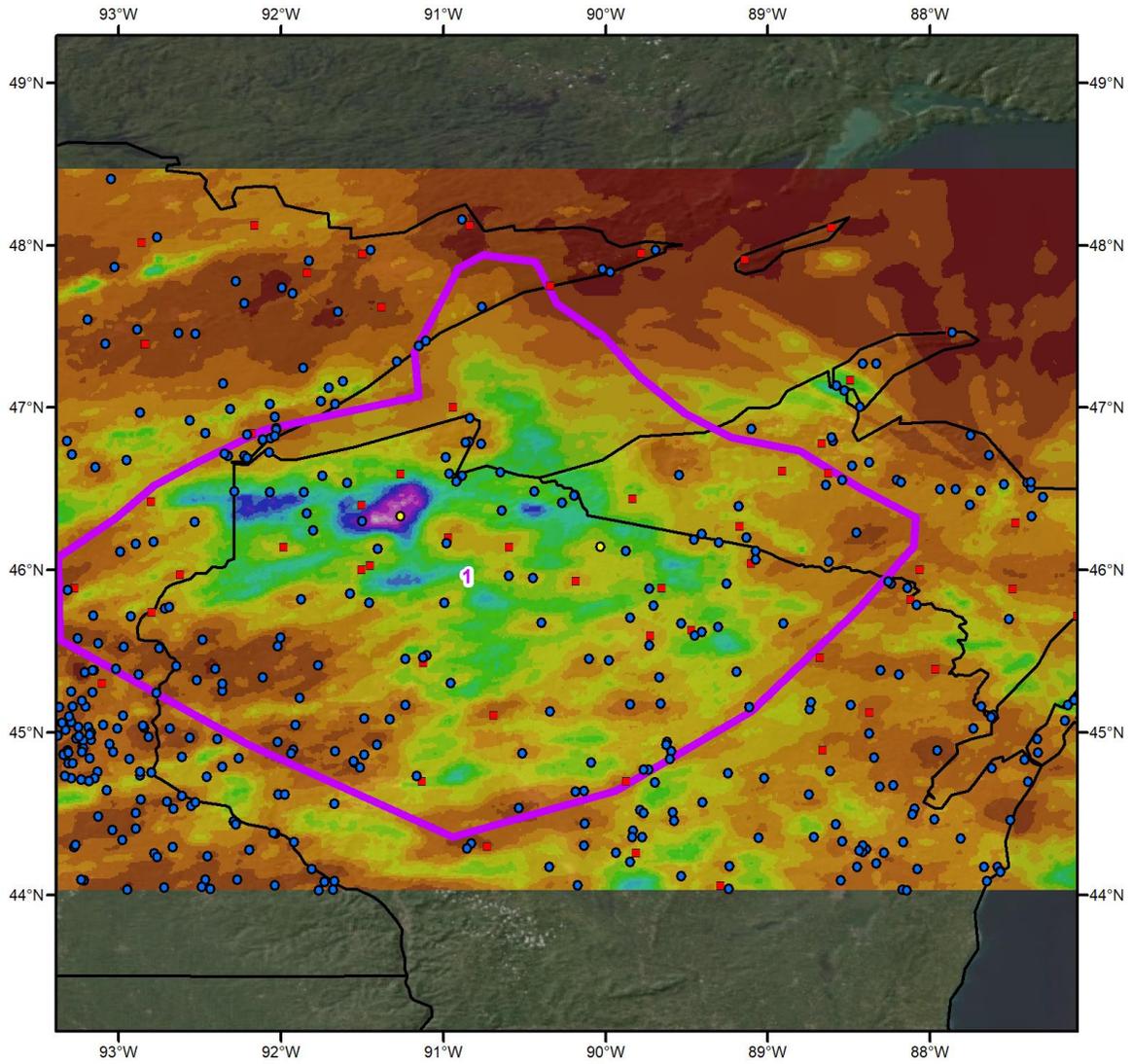
SPAS 1727 - June 15 (0600 UTC) - June 18 (1100 UTC), 2018													
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)													
Area (mi ²)	Duration (hours)												
	1hr	2hr	3hr	4hr	5hr	6hr	12hr	18hr	24hr	36hr	48hr	72hr	Total (78hr)
0.4	4.01	5.08	6.46	7.33	9.68	10.54	11.85	12.19	13.58	13.64	14.99	17.30	17.30
1	3.98	5.00	6.39	7.26	9.59	10.44	11.75	12.08	13.45	13.54	14.85	17.15	17.15
10	3.86	4.68	6.23	7.12	9.08	9.94	11.24	11.53	12.91	12.98	14.19	16.57	16.58
25	3.68	4.58	6.06	7.00	8.48	9.36	10.64	10.93	12.33	12.39	13.45	16.22	16.23
50	3.43	4.44	5.85	6.82	7.83	8.74	10.08	10.46	11.84	11.91	12.85	15.88	15.89
100	3.11	4.20	5.47	6.45	7.13	8.05	9.47	10.00	11.35	11.42	12.25	15.46	15.46
150	2.92	3.95	5.14	6.12	6.75	7.64	9.05	9.73	11.06	11.13	11.87	15.12	15.13
200	2.79	3.78	4.90	5.85	6.47	7.37	8.73	9.51	10.86	10.93	11.56	14.78	14.78
300	2.55	3.61	4.46	5.38	6.09	6.93	8.31	9.16	10.53	10.60	11.02	14.16	14.16
400	2.35	3.47	4.15	5.02	5.80	6.62	7.94	8.88	10.23	10.31	10.65	13.69	13.70
500	2.22	3.34	3.96	4.76	5.51	6.32	7.65	8.62	9.97	10.06	10.35	13.34	13.34
1,000	1.93	2.84	3.42	4.05	4.60	5.32	6.60	7.81	8.95	9.01	9.24	12.04	12.04
2,000	1.60	2.25	2.90	3.43	3.88	4.34	5.52	6.85	7.78	7.88	8.07	10.72	10.73
3,500	1.32	1.90	2.42	2.92	3.28	3.56	4.65	5.87	6.68	6.85	7.21	9.72	9.74
5,000	1.14	1.64	2.11	2.53	2.87	3.12	4.19	5.22	5.99	6.20	6.64	9.14	9.16
7,500	0.92	1.33	1.73	2.11	2.41	2.59	3.71	4.53	5.21	5.47	6.05	8.37	8.41
10,000	0.74	1.19	1.49	1.82	2.10	2.28	3.33	4.05	4.71	4.99	5.52	7.86	7.90
15,000	0.52	0.98	1.25	1.45	1.68	1.87	2.76	3.43	4.04	4.35	4.84	6.98	7.07
20,000	0.41	0.81	1.10	1.27	1.40	1.56	2.35	2.99	3.55	3.87	4.25	6.39	6.50
34,917	0.26	0.50	0.73	0.91	1.02	1.12	1.48	2.08	2.61	2.99	3.26	4.95	5.06

**SPAS 1727 DAD Curves Zone 1
June 15 (0600UTC) to June 18 (1100UTC), 2018**



SPAS 1727 Storm Center Mass Curve Zone 1
June 15 (0600UTC) to June 18 (1100UTC), 2018
Lat: 46.315 Lon: -91.415

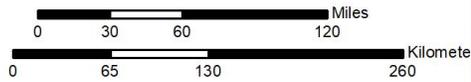




Total Storm (78-hr) Precipitation (inches)
6/15/2018 0600 UTC - 6/18/2018 1100 UTC
SPAS-NEXRAD #1727

Gauges

- Daily
- Hourly
- Supplemental



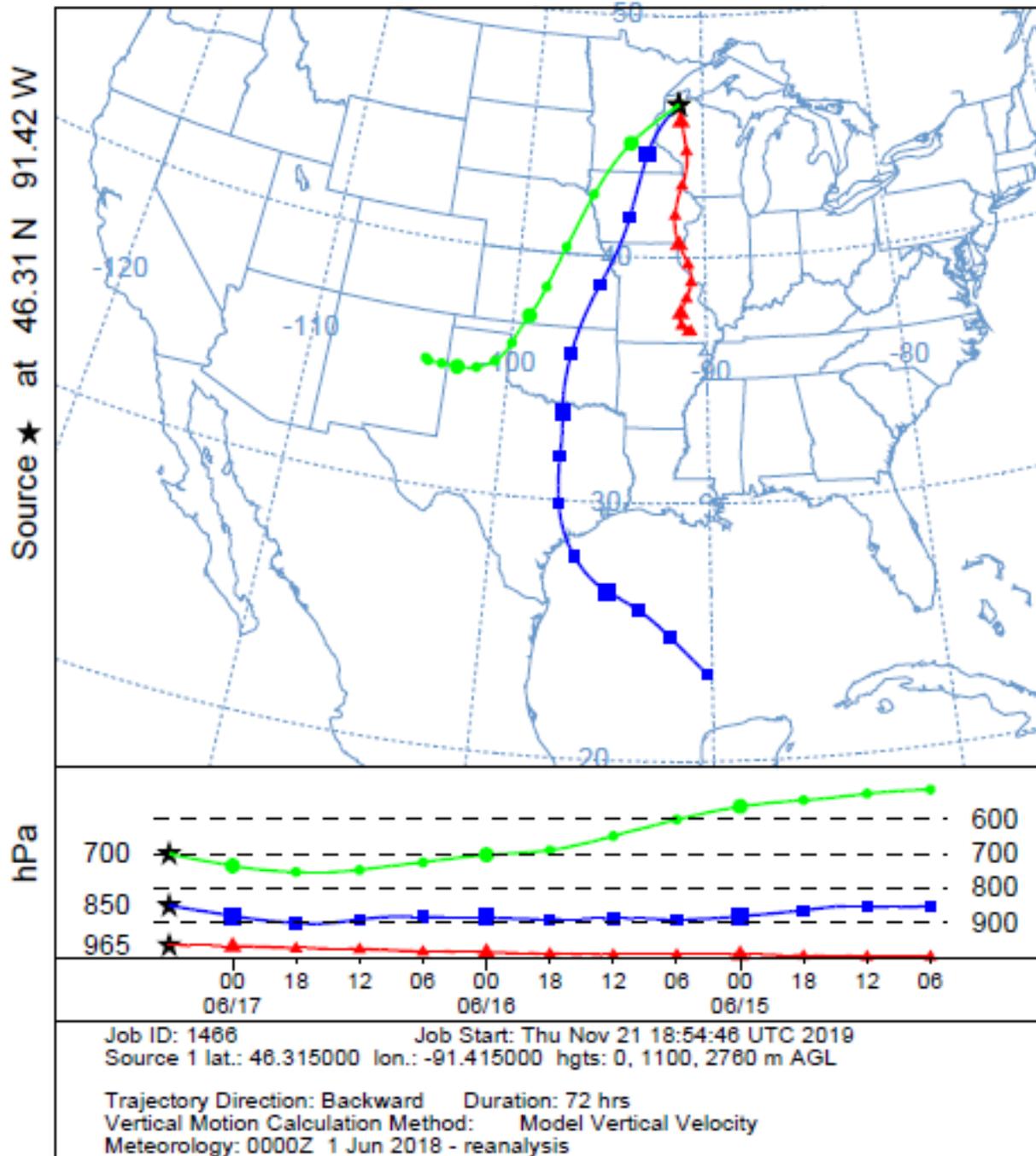
Precipitation (inches)

0.08 - 1.00	4.01 - 5.00	8.01 - 9.00	12.01 - 13.00	16.01 - 17.00
1.01 - 2.00	5.01 - 6.00	9.01 - 10.00	13.01 - 14.00	17.01 - 18.00
2.01 - 3.00	6.01 - 7.00	10.01 - 11.00	14.01 - 15.00	
3.01 - 4.00	7.01 - 8.00	11.01 - 12.00	15.01 - 16.00	

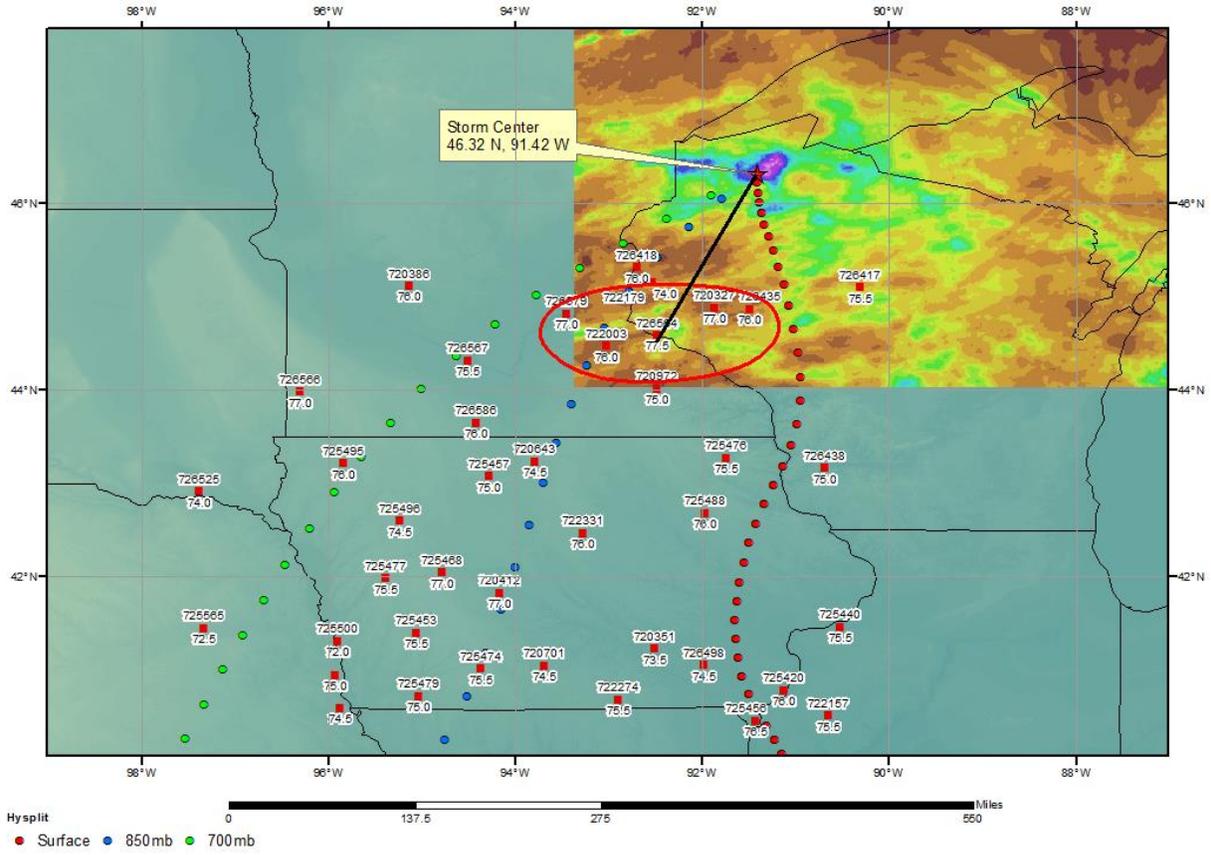


11/21/2019

NOAA HYSPLIT MODEL
 Backward trajectories ending at 0600 UTC 17 Jun 18
 CDC1 Meteorological Data



SPAS 1727 Storm Analysis June 16-17, 2018



Storm Precipitation Analysis System (SPAS) For Storm #1728_1 SPAS-NEXRAD Analysis

General Storm Location: Cross Plains, WI

Storm Dates: August 20-22, 2018

Event: Local

DAD Zone 1

Latitude: 43.1450

Longitude: -89.6150

Max. Grid Rainfall Amount: 16.24"

Max. Observed Rainfall Amount: 15.28"

Number of Stations: 656

SPAS Version: 10

Basemap: 80/20 split of radar and ippt

Spatial resolution: 0.3502

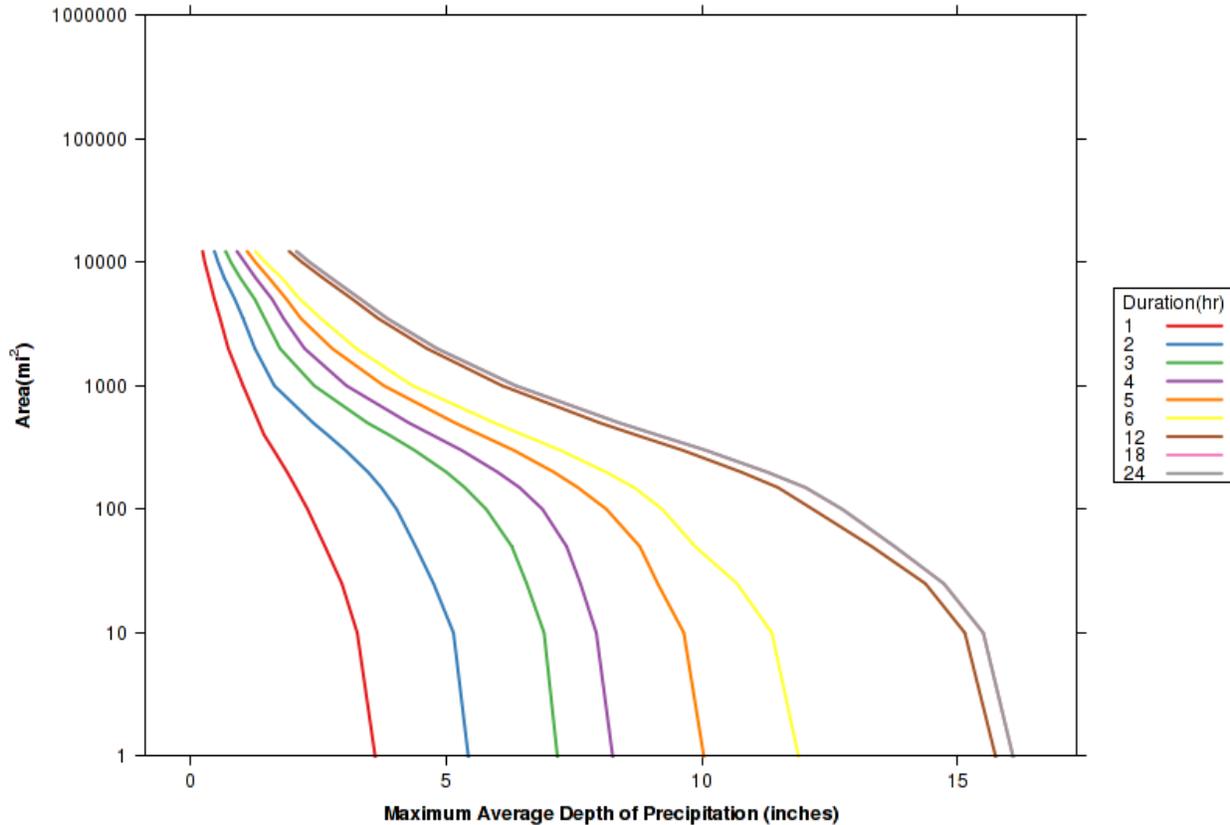
Radar Included: Yes

Depth-Area-Duration (DAD) analysis: Yes

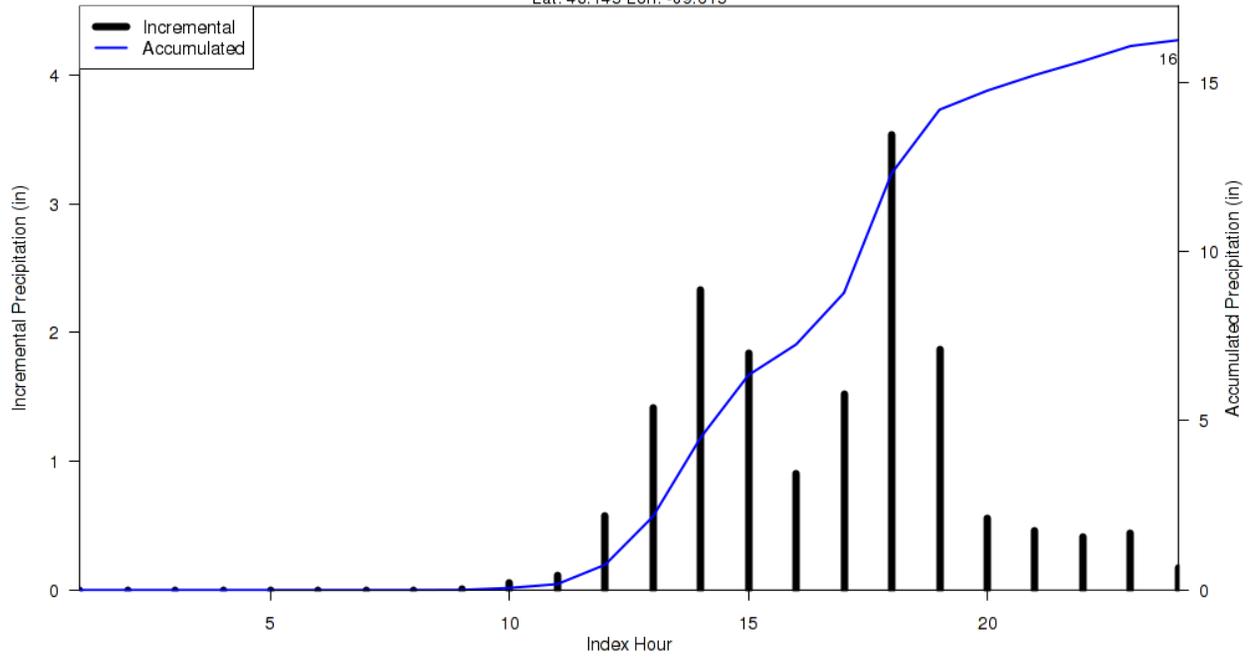
Reliability of results: This analysis was based on 656 hourly stations, daily data, supplemental station data and NEXRAD Radar. We have a good degree of confidence for the radar/station based storm total results. The spatial pattern is dependent on the radar data and basemap. Timing is based on the hourly and hourly pseudo stations. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

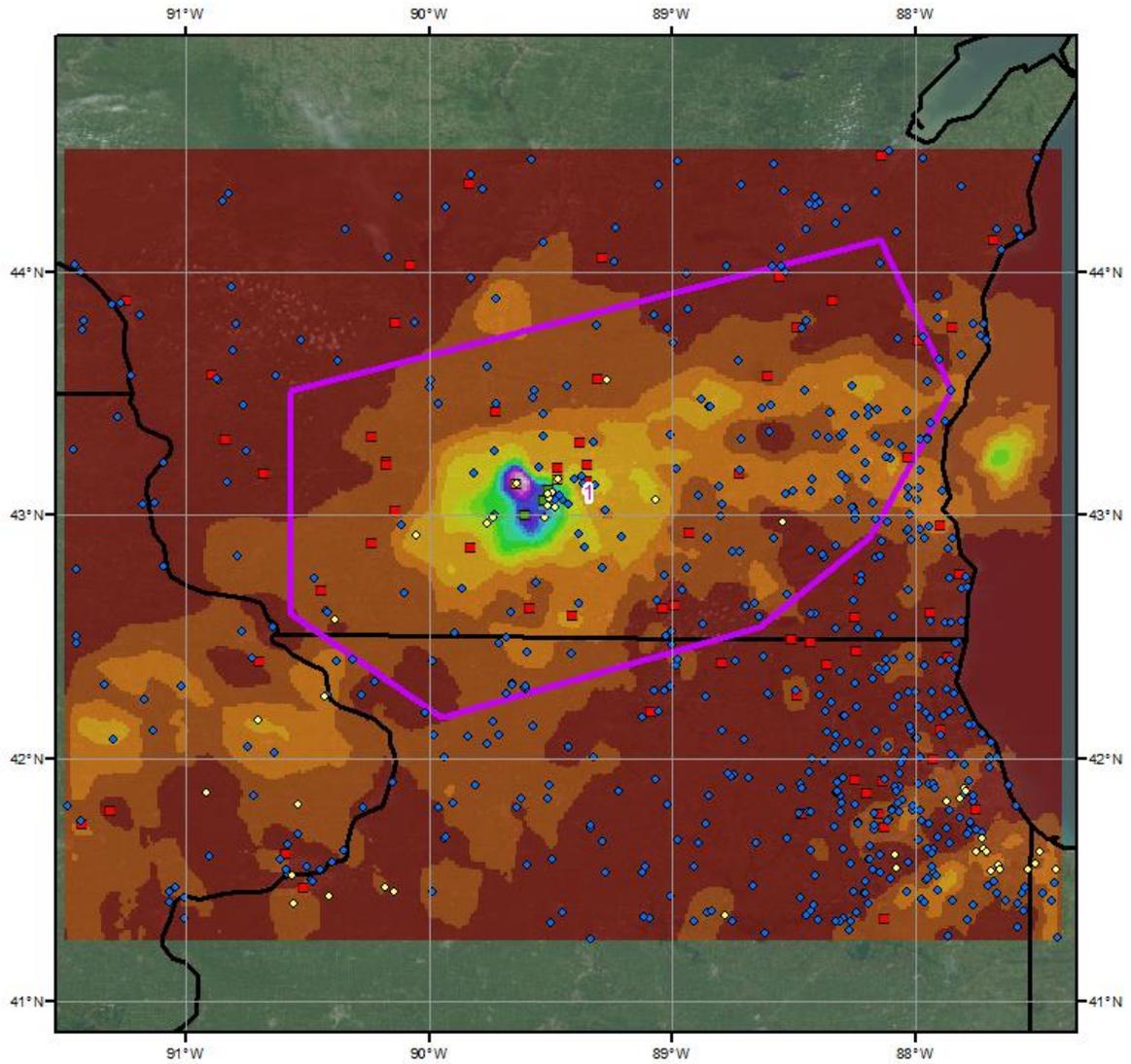
SPAS 1728 - August 20 (1000 UTC) - August 21 (0900 UTC), 2018										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	2	3	4	5	6	12	18	24	Total
0.4	3.65	5.50	7.24	8.33	10.13	12.00	15.87	16.22	16.22	16.22
1	3.62	5.44	7.18	8.26	10.04	11.89	15.74	16.08	16.08	16.08
10	3.27	5.15	6.92	7.94	9.65	11.37	15.14	15.50	15.50	15.50
25	2.97	4.76	6.58	7.63	9.14	10.69	14.37	14.73	14.73	14.73
50	2.64	4.41	6.29	7.36	8.79	9.87	13.32	13.76	13.77	13.76
100	2.30	4.04	5.79	6.89	8.14	9.23	12.17	12.74	12.75	12.74
200	1.90	3.48	5.01	6.01	7.11	8.13	10.77	11.27	11.28	11.27
300	1.64	3.04	4.39	5.31	6.33	7.24	9.63	10.08	10.08	10.08
400	1.45	2.69	3.89	4.73	5.68	6.51	8.71	9.12	9.13	9.12
500	1.35	2.41	3.47	4.28	5.18	5.95	8.01	8.39	8.39	8.39
1,000	1.04	1.65	2.43	3.06	3.79	4.35	6.10	6.36	6.37	6.36
2,000	0.75	1.27	1.76	2.24	2.78	3.25	4.63	4.82	4.83	4.82
5,000	0.48	0.88	1.27	1.61	1.89	2.15	3.18	3.34	3.34	3.34
10,000	0.29	0.55	0.80	1.07	1.28	1.47	2.19	2.33	2.34	2.33
12,235	0.25	0.48	0.70	0.92	1.12	1.28	1.94	2.08	2.08	2.08

**SPAS 1728 DAD Curves Zone 1
August 20 (1000UTC) to August 21 (0900UTC), 2018**



SPAS 1728 Storm Center Mass Curve Zone 1
August 20 (1000UTC) to August 21 (0900UTC), 2018
Lat: 43.145 Lon: -89.615

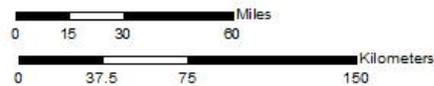




**Total Storm (24-hours) Precipitation (inches)
 August 20 (1000 UTC) - August 21 (0900 UTC), 2018
 SPAS NEXRAD 1728 - Cross Plains, WI**

Gauges

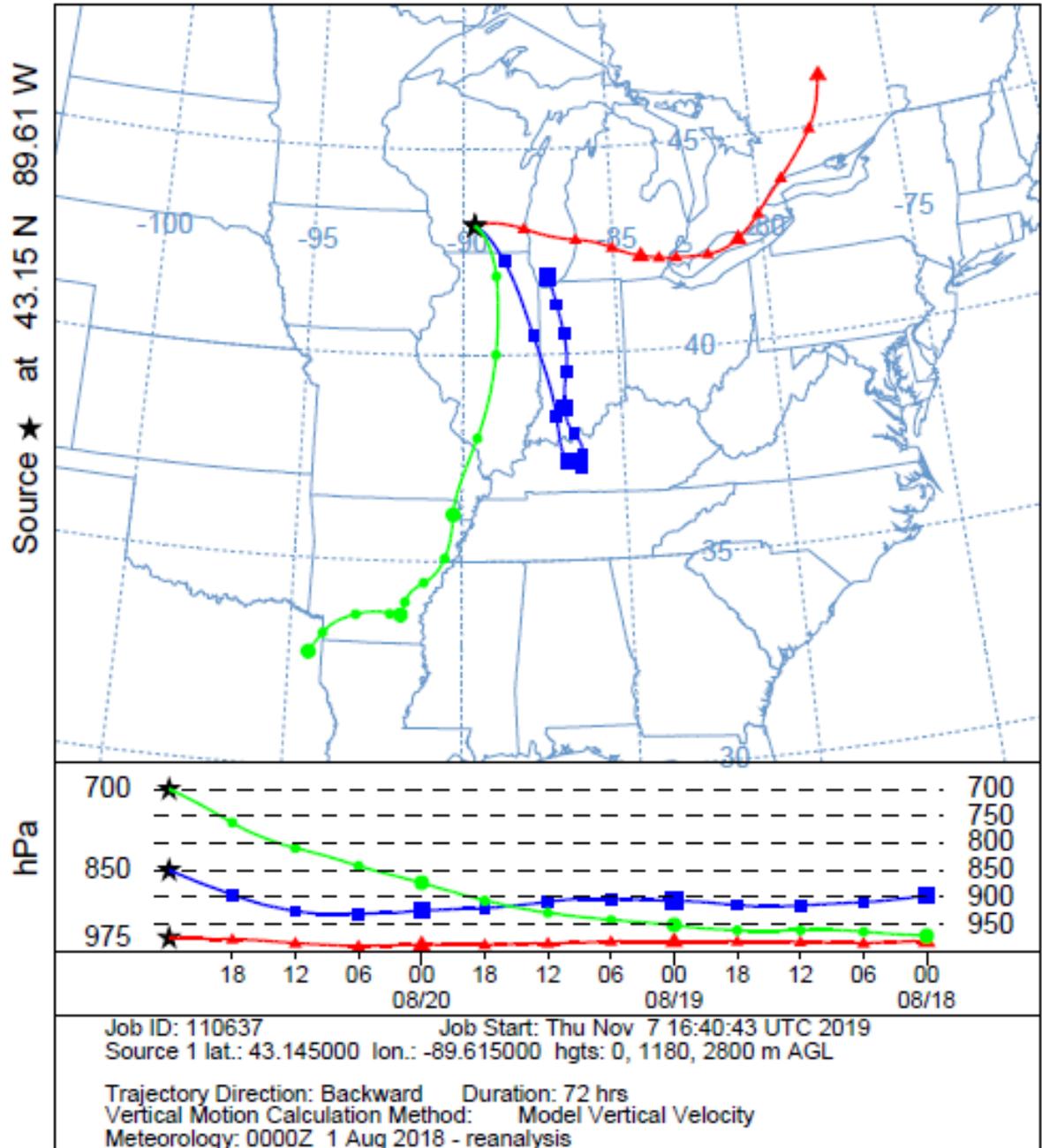
- ◆ Daily
- Hourly
- HEP
- Hourly Pseudo
- ◆ Supplemental
- ◆ SE



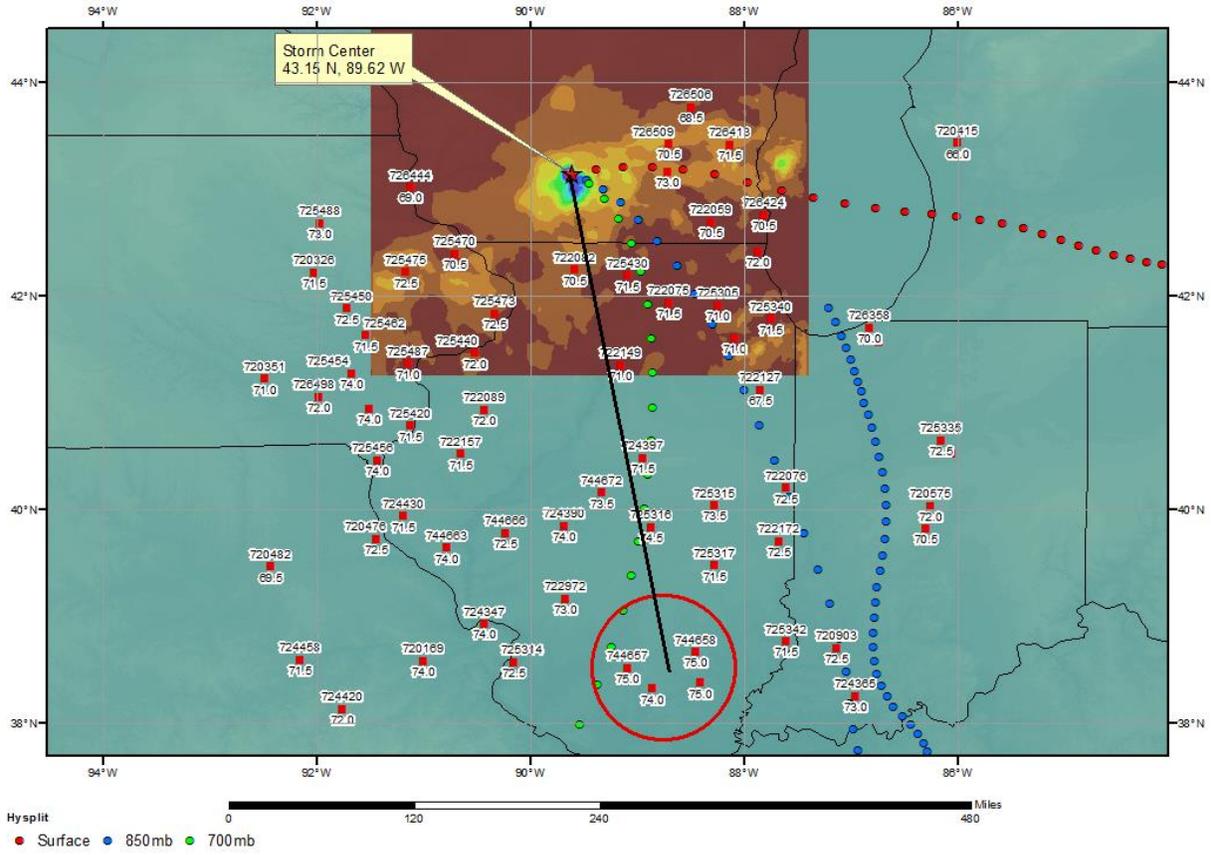
Precipitation (inches)	4.01 - 5.00	9.01 - 10.00	14.01 - 15.00
0.00 - 1.00	5.01 - 6.00	10.01 - 11.00	15.01 - 16.00
1.01 - 2.00	6.01 - 7.00	11.01 - 12.00	16.01 - 17.00
2.01 - 3.00	7.01 - 8.00	12.01 - 13.00	
3.01 - 4.00	8.01 - 9.00	13.01 - 14.00	



NOAA HYSPLIT MODEL
 Backward trajectories ending at 0000 UTC 21 Aug 18
 CDC1 Meteorological Data



SPAS 1728 Storm Analysis August 19-21, 2018



Storm Precipitation Analysis System (SPAS) For Storm #1729_1 SPAS-NEXRAD Analysis

General Storm Location: Iron River, MI

Storm Dates: July 20-21, 2019

Event: Local

DAD Zone 1

Latitude: 44.0350

Longitude: -86.1850

Max. Grid Rainfall Amount: 15.77"

Max. Observed Rainfall Amount: 13.53"

Number of Stations: 707

SPAS Version: 10

Basemap: Default ZR Relationship 3001.4

Spatial resolution: 0.35

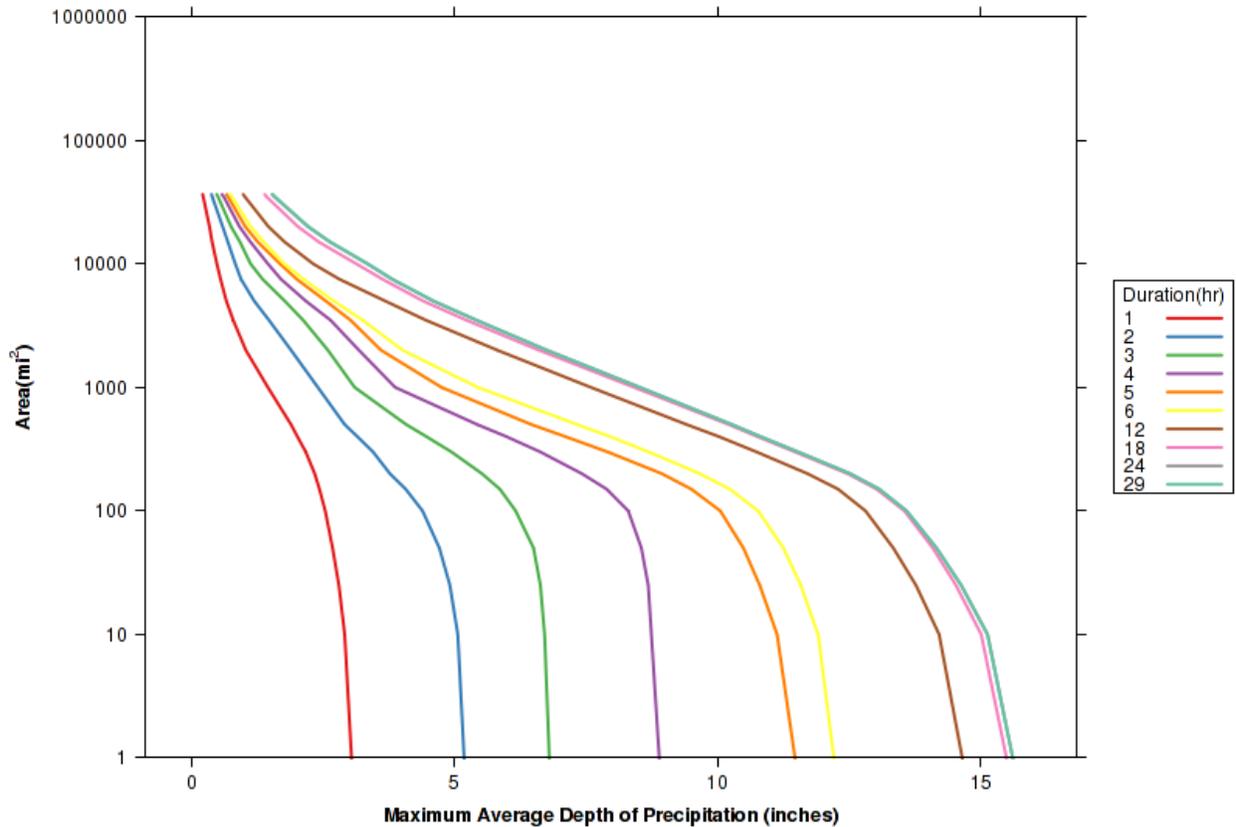
Radar Included: Yes

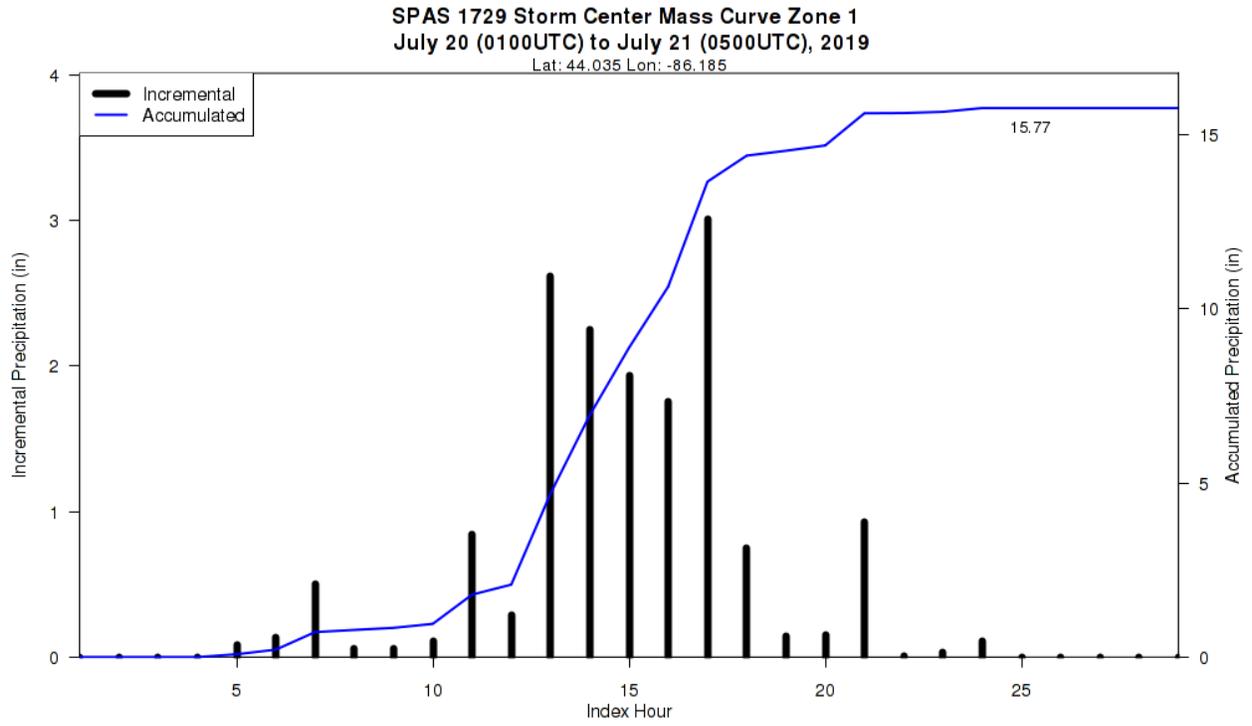
Depth-Area-Duration (DAD) analysis: Yes

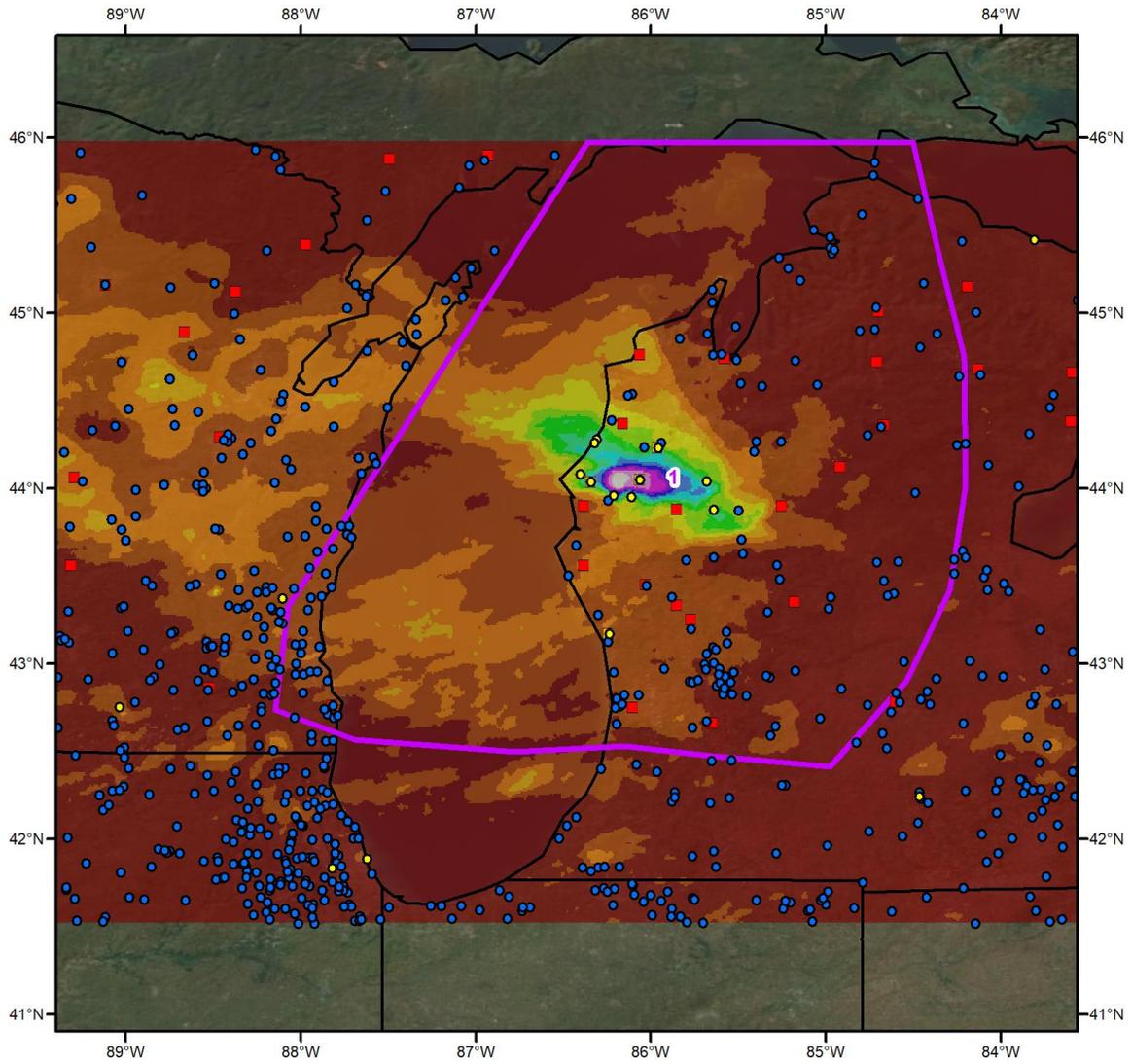
Reliability of results: This analysis was based on 707 hourly stations, daily data, supplemental station data and radar data. We have a good degree of confidence for the radar and station based storm total results. The spatial pattern is fully dependent on the radar data and basemap. Timing is based on hourly stations and sun-hourly data is based on 5-minute radar data. Several daily stations were moved to supplemental due to timing issues and to ensure data consistency.

SPAS 1729 - July 20 (0100 UTC) - July 21 (0500 UTC), 2019										
MAXIMUM AVERAGE DEPTH OF PRECIPITATION (INCHES)										
Area (mi ²)	Duration (hours)									
	1	2	3	4	5	6	12	18	24	Total
0.4	3.07	5.23	6.83	8.95	11.56	12.30	14.78	15.61	15.75	15.61
1	3.04	5.18	6.80	8.89	11.47	12.21	14.65	15.49	15.61	15.49
10	2.91	5.06	6.71	8.74	11.13	11.91	14.21	15.01	15.13	15.01
25	2.80	4.91	6.63	8.68	10.80	11.58	13.77	14.53	14.63	14.53
50	2.68	4.71	6.50	8.55	10.49	11.25	13.34	14.09	14.16	14.09
100	2.54	4.39	6.16	8.30	10.05	10.77	12.81	13.55	13.59	13.55
200	2.34	3.77	5.52	7.42	8.94	9.66	11.71	12.47	12.52	12.47
300	2.17	3.45	4.94	6.63	7.91	8.69	10.74	11.47	11.53	11.47
400	2.01	3.15	4.46	5.98	7.10	7.95	10.02	10.75	10.81	10.75
500	1.89	2.91	4.08	5.43	6.46	7.33	9.41	10.21	10.27	10.21
1,000	1.45	2.40	3.10	3.87	4.75	5.44	7.59	8.41	8.52	8.41
2,000	1.03	1.89	2.59	3.18	3.60	4.01	5.81	6.60	6.75	6.60
5,000	0.66	1.19	1.77	2.17	2.55	2.70	3.68	4.40	4.59	4.40
10,000	0.48	0.83	1.12	1.45	1.68	1.76	2.31	3.13	3.34	3.13
20,000	0.34	0.59	0.75	0.91	1.02	1.12	1.46	2.02	2.21	2.02
35,000	0.22	0.39	0.50	0.61	0.69	0.76	1.01	1.42	1.57	1.42
36,448	0.21	0.38	0.48	0.58	0.67	0.74	0.98	1.39	1.53	1.39

SPAS 1729 DAD Curves Zone 1
July 20 (0100UTC) to July 21 (0500UTC), 2019



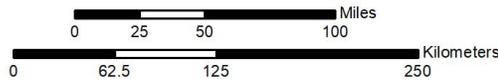




Total Storm (29-hr) Precipitation (inches)
07/20/2019 0100 UTC - 07/21/2019 0500 UTC
SPAS-NEXRAD #1729

Gauges

- Daily
- Hourly
- Hourly Pseudo
- Supplemental



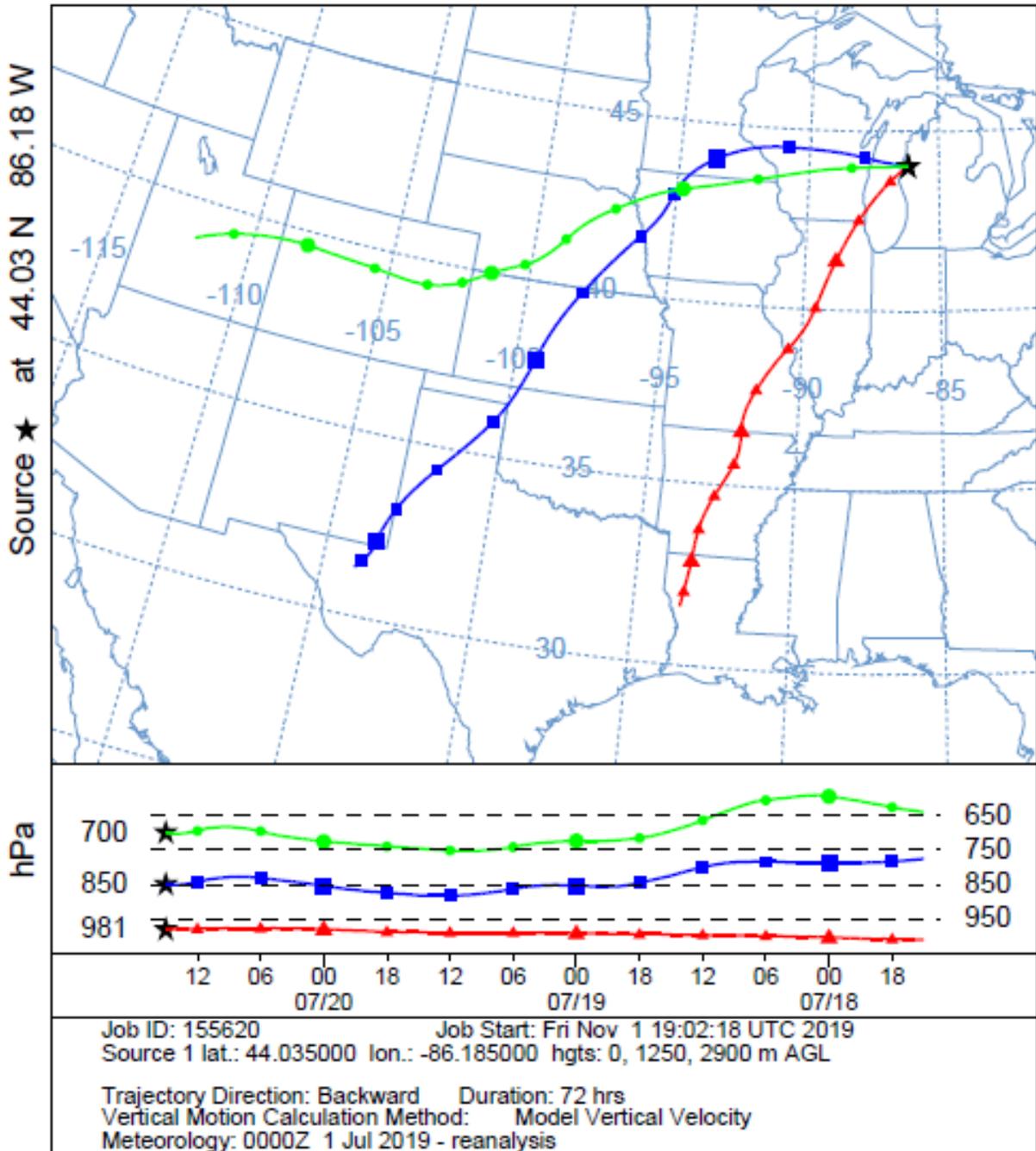
Precipitation (inches)

- | | | | | |
|---------------|---------------|---------------|-----------------|-----------------|
| ■ 0.00 - 1.00 | ■ 3.01 - 4.00 | ■ 6.01 - 7.00 | ■ 9.01 - 10.00 | ■ 12.01 - 13.00 |
| ■ 1.01 - 2.00 | ■ 4.01 - 5.00 | ■ 7.01 - 8.00 | ■ 10.01 - 11.00 | ■ 13.01 - 14.00 |
| ■ 2.01 - 3.00 | ■ 5.01 - 6.00 | ■ 8.01 - 9.00 | ■ 11.01 - 12.00 | ■ 14.01 - 15.00 |



10/31/2019

NOAA HYSPLIT MODEL
 Backward trajectories ending at 1500 UTC 20 Jul 19
 CDC1 Meteorological Data



SPAS 1729 Storm Analysis July 19-20, 2019

